



# ARTHROPOD-BORNE VIRUS INFORMATION EXCHANGE

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**IMPORTANT NOTICE:** This exchange is issued for the sole purpose of timely exchange of information among investigators of arthropodborne viruses. It contains reports, summaries, observations, and comments submitted voluntarily by qualified agencies and investigators. The appearance of any information, data, opinions, or views in this exchange does not constitute formal publication. Any reference to or quotation of any part of this exchange must be authorized directly by the person or agency which submitted the text.

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COMMENTS FROM THE EDITOR

You will receive this issue of the Arthropod-borne Virus Information Exchange considerably later than anticipated.

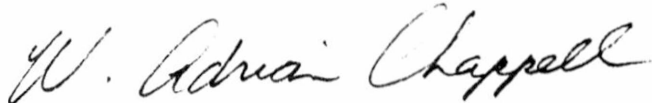
Very little editing was required of the articles submitted for this issue; however, a few reports were not single spaced and a few tables and figures were not numbered. You are requested to refer to "Guides for Authors" in this issue before submitting your next report.

Again you are encouraged to send in items of general interest to arbovirologists such as information on retirements, changes in employment, deaths, honors, meetings, publication of books, etc.

If you are thinking about submitting an article for the next issue, the deadline is September 1, 1982. Perhaps you should consider mailing it before your summer vacation to assure delivery before the deadline. Please address communications to:

W. Adrian Chappell, Editor  
Arthropod-borne Virus Information Exchange  
Biological Products Production Branch  
Centers for Disease Control  
Atlanta, Georgia 30333, U.S.A.

If you have suggestions for improving the "Information Exchange", please let me hear from you.

  
W. Adrian Chappell, Ph.D.

## GUIDE FOR AUTHORS

The Arthropod-borne Virus Information Exchange is issued for the purpose of timely exchange of information among investigators of arthropod-borne viruses. It contains reports, summaries, observations, and comments submitted voluntarily by qualified investigators. The appearance of any information, data, opinions, or views in this publication does not constitute formal publication. Any reference to or quotation of any part of this publication must be authorized directly by the person or agency submitting the article. The editor of the "Information Exchange" cannot authorize references and quotations.

Deadlines for articles to be published are March 1 and September 1.

The following format should be used for all articles submitted:

1. Heading

The heading should be typed with capital letters, including name of laboratory and address. For example:

REPORT FROM THE BIOLOGICAL PRODUCTS PRODUCTION BRANCH, CENTER FOR  
INFECTIOUS DISEASES, CENTERS FOR DISEASE CONTROL, ATLANTA, GA. 30333

2. Body of Report

The text of the report should be as brief as possible to convey the intended message and should make reference to tables and figures included in the report. The text should be single spaced with double spacing between paragraphs.

3. Authors' Names

The names of authors should be in parentheses following the text.

4. Tables and Figures

Tables and figures should be numbered and titled if appropriate. Tables and figures should not be submitted without some description or explanation.

Reports should be typed only on one side of each page since they have to be photographed for reproduction. Each page should be numbered. Only the original typed report should be submitted.

Dr. Richard M. Taylor, 1887 - 1981

Dr. Richard Moreland Taylor died on April 13, 1981. He retired as Chairman of the Subcommittee on Information Exchange on July 1, 1968, and was succeeded by Dr. Trygve O. Berge. He continued to serve the Subcommittee as a Consultant and remained a member until his death.

Dr. Taylor was one of a small group of pioneering arbovirologists who laid the ground work for an American organization which ultimately became International in scope. This group developed a formal organizational structure which subsequently comprised the American Committee on Arthropod-borne Viruses and its Subcommittees. Dr. Taylor brilliantly directed the establishment of the Catalogue of Arthropod-borne Viruses of the World, and guided the operation of the Subcommittee on Information Exchange from the inception of there activities in 1960 until he retired in 1968.

During his tenure as Chairman he initiated, with expert assistance, the development and subsequent implementation of a program for computer storage and retrieval of information on registered viruses. Under his editorship, a published version of the working Catalogue was issued in 1967. This first published edition was a facsimile of the February 1967 version of the working Catalogue. It contained information on 204 registered viruses, and was distributed worldwide. The international recognition and acceptance of this universal system of scientific documentation stands as a tribute to the insight, ingeniousness and untiring efforts of Dr. Richard M. Taylor.

(Submitted by N. Karabatsos)

## PUBLICATIONS

The following book will be published by the Oxford University Press in April, 1982:

"Practical Virology for Medical Students and Practitioners in Tropical Countries" by D. Metselaar and D.I.H. Simpson

This book contains chapters on arboviruses, the Marburgvirus Group, and Arenaviruses.

The following book was published in 1981 by the USSR Academy of Medical Sciences, The D.I. Ivanovsky Institute of Virology, Moscow:

"Arboviruses, Collection of Papers", Edited by S. Ya Gaidamovich

This collection of papers contains articles on the biology and ecology of arboviruses, etiology, prophylaxis, and laboratory diagnosis of arboviral infections. The data published reflect the results of investigations carried out in 1978 to 1980. Materials are presented on the study of experimental chronic arboviral infections, isolation of new strains of arboviruses, in particular Isfahan rhabdovirus, the role of arboviruses (isolated in the USSR) in the pathology of man, and improvement of laboratory diagnosis involving the use of indirect hemagglutination and gel radial hemolysis.

These articles are in Russian with abstracts in English.



# The AMERICAN COMMITTEE ON ARTHROPOD-BORNE VIRUSES

## SUBCOMMITTEE ON EVALUATION OF ARTHROPOD-BORNE STATUS

### CHAIRMAN

Thomas H. G. Aitken  
Yale University School of Medicine  
Dept. Epidemiology and Public Health  
60 College Street  
New Haven, Connecticut 06510

### MEMBERS

Roy W. Chamberlain  
Virology Division  
Center for Disease Control  
Atlanta, Georgia 30333

### D. Bruce Francy

Vector-Borne Diseases Division  
Center for Disease Control  
P.O. Box 2087  
Ft. Collins, Colorado 80522

### James L. Hardy

School of Public Health  
Earl Warren Hall  
University of California  
Berkeley, California 94720

### Donald M. McLean

Division of Medical Microbiology  
University of British Columbia  
Vancouver 8  
British Columbia, Canada

### John P. Woodall

New York State Dept. of Health  
Division of Laboratories and Research  
New Scotland Avenue  
Albany, New York 12201

## REPORT FROM THE SUBCOMMITTEE ON EVALUATION OF ARTHROPOD-BORNE STATUS (SEAS) FOR 1981

During 1981, only five newly registered viruses and two previously reviewed viruses were evaluated by this subcommittee.

These viruses and their sources are as follows:

1. Hantaan. Ungrouped - Korea, rodent.
2. Douglas. Group Simbu - Northern Territory, Australia, cow.
3. Tinaroo. Group Simbu - Queensland, Aust., Culicoides.
4. Tehran. Group Phlebotomus fever - Iran, phlebotomine.
5. Aransas Bay. Group Upolu - Texas, U.S.A., tick.

All of these agents were considered "possible" arboviruses with the exception of Douglas which was rated a "probable" arbovirus.

Two viruses, Rocio (group B) and San Angelo (Group Calif. enceph.) were upgraded to full arbovirus status on the basis of experimental mosquito transmission studies and, in the latter case, verification of transovarial transmission.

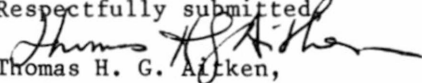
Early in 1981 this subcommittee submitted a statement to the Arbovirus Info-Exchange (No. 40, March) reviewing arbovirus evaluations since the appearance of the 2nd Arbovirus Catalogue. Readers were urged to try and submit more complete new virus registrations and to attempt arthropod infection experiments.

SEAS submitted a brief report to the ACAV Open Meeting, 5th International Congress of Virology held in Strasbourg, 1-8 August 1981. Dr. Woodall read the report.

During the year, Dr. Duane Gubler joined the subcommittee, filling the vacancy created by the resignation of Dr. Albert Rudnick.

THGA:cb

Respectfully submitted

  
Thomas H. G. Aitken,  
Chairman

October 1981





# The AMERICAN COMMITTEE ON ARTHROPOD-BORNE VIRUSES

1981 ANNUAL REPORT ON THE CATALOGUE OF ARTHROPOD-BORNE AND  
SELECTED VERTEBRATE VIRUSES OF THE WORLD\*

By

THE SUBCOMMITTEE ON ARTHROPOD-BORNE VIRUS  
INFORMATION EXCHANGE

## INFORMATION EXCHANGE SUBCOMMITTEE

CHAIRMAN and INFORMATION  
EXCHANGE EDITOR  
Roy W. Chamberlain  
Virology Division  
Center for Disease Control  
Atlanta, Georgia 30333

CATALOGUE and ABSTRACT  
EDITOR  
Nick Karabatsos  
Vector-Borne Diseases Division  
Center for Disease Control  
P.O. Box 2087  
Fort Collins, Colorado 80522

YARU LIAISON  
Robert E. Shope  
Yale University School of Medicine  
Dept. Epidemiology and Public Health  
60 College Street  
New Haven, Connecticut 06510

CATALOGUE CONSULTANT  
T. O. Berge  
2305 Hillside Way  
Boulder, Colorado 80303

### I. Objectives:

The objectives of the Catalogue are to register data concerning occurrence and characteristics of newly recognized arthropod-borne viruses and other viruses of vertebrates of demonstrated or potential zoonotic importance, and to disseminate this information at quarterly intervals to participating scientists in all parts of the world; to collect, reproduce, collate, and distribute current information regarding registered viruses from published materials, laboratory reports, and personal communications; and to prepare and distribute an annual summary of data extracted from catalogued virus registrations.

### II. Materials and Methods:

Viruses are registered and information supplied on a voluntary basis, usually by scientists responsible for their isolation and identification. New registration cards, information concerning registered viruses, and pertinent abstracts of published literature are distributed at quarterly intervals to participating laboratories. Abstracts of published articles dealing with catalogued viruses are reproduced by special arrangements with the editors of Biological Abstracts, Abstracts on Hygiene, and the Tropical Diseases Bulletin.

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\* The Catalogue is supported by the Center for Disease Control, Atlanta, Georgia.

NOTE: This report is not a publication and should not be used as a reference source in published bibliographies.

Distribution of Catalogue Materials: At the start of 1981, 173 mailings of Catalogue material were being made. During the year, 3 addresses were dropped and 5 new participants were added to the mailing list. At the end of the year, 175 mailings of Catalogue material were being made, including 62 within the U.S.A. and 113 to foreign addresses. Distribution by continent was: Africa 19, Asia 21, Australasia 7, Europe 37, North America 74, and South America 17.

Abstracts and Current Information: A total of 437 abstracts or references were coded by subject matter and distributed to participants during 1981. Of this total, 276 were obtained from Biological Abstracts, 152 from Abstracts on Hygiene and the Tropical Diseases Bulletin, and 9 from current journals, personal communications, or other sources. A total of 13,193 references or units of information have been issued since the start of the program.

Registration of New Viruses: Eleven new viruses were registered during 1981. As of December 1980, the Catalogue contained 435 registered viruses. With the acceptance of eleven new virus registrations during 1981, the total number of registered viruses increased to 446 as of December 1981. The viruses registered during 1981 are listed below:

<u>Virus Name</u>	<u>Recommended Abbreviation</u>	<u>Country</u>	<u>Source</u>	<u>Antigenic Group</u>
Aroa	AROA	Venezuela	Sentinel hamster	B
Cr. Hem. Fever	CHF	U.S.S.R.	Man	CHF-CON
San Perlita	SP	U.S.A.	Rodent	B
Sal Vieja	SV	U.S.A.	Rodent	B
Virgin River	VR	U.S.A.	Mosquitoes	ANA
Lednice	LED	Czech.	Mosquitoes	TUR
Hantaan	HTN	Korea	Rodent	
Douglas	DOU	Australia	Bovine	SIM
Tinaroo	TIN	Australia	Culicoides sp.	SIM
Tehran	TEH	Iran	Phlebotomus sp.	PHL
Aransas Bay	AB	U.S.A.	Argasid ticks	UPO

These registered viruses were isolated between 1960 and 1979. TEH was isolated in 1960, LED in 1963, CHF in 1967, SP in 1972, VR in 1974, AROA and AB in 1975, HTN in 1976, DOU and SV in 1978, and TIN in 1979.

Crimean hemorrhagic fever was evaluated as an Arbovirus by the Subcommittee on Evaluation of Arthropod-Borne Status (SEAS)\*, Douglas and Lednice viruses were evaluated as Probable Arbovirus while all others were evaluated as Possible Arbovirus.

Both Crimean hemorrhagic fever and Hantaan viruses have been isolated from man, and both have been reported to produce a serious and wide-spread disease in man. Each virus produces a hemorrhagic fever type of disease; however, that produced by Hantaan virus also is associated with a renal syndrome.

\* T.H.G. Aitken (Chairman), E.W. Cupp, D.B. Francly, D. Gubler, J.L. Hardy, D.M. McLean, and J.P. Woodall

It should be mentioned again; Crimean hemorrhagic fever virus is antigenically indistinguishable from the previously registered Congo virus. The registration for Crimean hemorrhagic fever virus contains information which is not found in the registration for Congo virus.

Antigenic Grouping: In last year's Annual Report, we reviewed the serological findings of Casals and Tignor, in which they demonstrated the existence of antigenic relationships between 5 serogroups of tick-borne viruses (1). At the same time these viruses were taxonomically classified as members of the Nairovirus genus in the Bunyaviridae family (2). While the serological paper was in press, the authors detected further cross-reactions between viruses of the Sakhalin serogroup and certain members of serogroups already placed in the Nairovirus genus (1). Thus, the Nairovirus genus now contains six serogroups: Crimean hemorrhagic fever - Congo (CHF-CON), Dera Ghazi Khan (DGK), Hughes (HUG), Nairobi sheep disease (NSD), Qalyub (QYB), and Sakhalin (SAK).

Following the appearance of last year's Annual Report, the first in a series of papers being prepared by the Subcommittee on Interrelationships Among Catalogued Arboviruses (SIRACA)\*\* appeared in press (3). The first paper carried the recommendations of SIRACA concerning the antigenic classification of registered alphaviruses. These recommendations have been presented and discussed previously in the Annual Report. Briefly, SIRACA has determined that the alphaviruses contain 6 complexes. There are 4 complexes each containing one virus serotype (EEE, MID, NDU, VEE). Two varieties of EEE virus are listed, and all other members of the VEE complex are designated as subtypes or varieties. The SF complex contains four virus serotypes (SF, CHIK, GET, MAY). The other members are designated as subtypes of either CHIK, GET or MAY. The sixth subset (WEE complex) contains 6 separate virus serotypes, one of which is not presently registered (Y62-33). Two additional members have been designated as subtypes of Sindbis virus.

Initial morphologic studies demonstrated that Jurona virus was a rhabdovirus, and subsequent serologic investigations placed it in the VSV serogroup ( ,5). Antigenic relationships of Jurona virus to members of the VSV serogroup were shown by immunofluorescent assay, complement-fixation and neutralization tests.

Taxonomic Status of Registered Viruses: It must be emphasized that reported changes in the taxonomic classification of registered arboviruses are of a provisional nature; and in some instances, new taxonomic placements are based on the barest of evidence. These methods provide the means by which the information in the Annual Report is kept current, and by which participants are informed of newer developments.

\*\* R.E. Shope (Chairman), W.E. Brandt, C.H. Calisher, J. Casals, D.L. Knudsen, J.W. Le Duc and R.B. Tesh.

Molecular analysis studies published within the last year indicate Turlock virus (Turlock serogroup) and Boraceia virus (Anopheles B serogroup) have virion RNA species and polypeptides comparable in size to those of members of the Bunyavirus genus and unlike those of members of the newly defined Phlebovirus, Nairovirus or Uukuvirus genera (6). Further, competition radioimmune assays have indicated that the virion polypeptides of Boraceia virus share antigenic determinants with other bunyaviruses and that Turlock virus shares antigenic determinants with La Crosse virus. Thus, the Anopheles B and Turlock serogroups taxonomically have been placed within the Bunyavirus genus.

Recently described but presently unpublished studies have indicated that the polypeptides of an unregistered member of the Thogoto serogroup resembles those of phleboviruses (7). In addition, further analysis has indicated that the RNA species and polypeptides of Silverwater virus (Kaisodi serogroup) resemble those of uukuviruses. Definitive taxonomic classification of these will await action by the Bunyaviridae Study Group, International Committee on Taxonomy of Viruses.

Morphologic and biochemical comparisons of Belmont virus with Bunyamwera virus have shown that the two viruses are similar in many respects, "providing strong evidence that Belmont virus belongs to the Bunyaviridae" (8,9).

Collaborative studies between the CDC laboratory in Fort Collins and that in Atlanta have provided new information on the morphological characteristics of certain registered viruses (10). Some of these registered viruses previously were ungrouped and/or unclassified. Virus-infected cell cultures preparations were examined by thin-section electron microscopy, and the following observations were reported. Nayando (Nyando serogroup), Matariya (Matariya serogroup), and Pacora viruses resembled typical bunyaviruses. Both Aruac and La Joya viruses possessed typical rhabdovirus morphology, while Ieri virus resembled an orbivirus. Two separate and independent studies have demonstrated that Jurona and Inhangapi viruses also possess rhabdovirus morphology (4,11). Interestingly, Jurona virus previously was antigenically linked to the Bunyamwera Supergroup as an unassigned virus (SBU) on the basis of low level HI cross-reactions with antibody to Oropouche virus and with Simbu and Bunyamwera grouping immune fluids.

Synopsis of Information in Catalogue: This synopsis has been compiled primarily to provide a short review of the viruses included in the Catalogue. The following tabulations are designed to draw together groups of viruses showing certain characteristics in common, listing viruses according to their known taxonomic status and by their demonstrated serological relationships, and where appropriate, by principal arthropod vector. Isolations from arthropod and animal hosts, continental distribution, involvement in human disease, and arbovirus status are indicated. Other tables summarize the taxonomic status of registered viruses; the antigenic groups comprising a given taxon to which registered viruses have been assigned; the numbers of registered

viruses assigned to presently recognized antigenic groups; chronology and areas of isolations of registered viruses; continental distribution by groups; numbers of viruses recovered from naturally infected arthropods and vertebrates; association with human disease; and evaluation of arthropod-borne status of members in various serogroups.

Table 1. Alphabetical and taxonomic listing of registered viruses:

Table 1 presents an alphabetical listing of the 446 viruses registered in the Catalogue as of December 1981. An official or provisional taxonomic classification is shown for each registered virus. If taxonomic status is not indicated, the registered virus is presently unclassified. Also, a recommended abbreviation is given for each virus, which has been formulated according to the guidelines established by the American Committee on Arthropod-Borne Viruses (12). All too often, abbreviations are employed in publications which are of the author's choosing and which do not conform to the recommended abbreviations. Their use is confusing, contrary to established guidelines, and erodes a portion of the effort of the Arbovirus Information Exchange program. All arbovirologists who plan to employ abbreviations in print should make every effort to use the recommended abbreviations.

Antigenic groups to which viruses have been assigned also are shown in this table. If no antigenic group is given, the virus is ungrouped and indicates that it has not been demonstrated to be serologically related to any other known arbovirus.

Table 2. Antigenic groups of registered viruses: The originally described antigenic groups of arboviruses were designated by letters, A, B, and C; but in present practice, the first discovered virus of a newly recognized serogroup lends its name to the antigenic cluster. Before a virus can be assigned to any antigenic group, it must be shown to be serologically related to, but clearly distinguishable from a previously isolated virus.

Table 2 lists the serogroups comprising the various taxa to which registered viruses have been assigned. Fifty-six antigenic groups have been established for viruses registered in the Catalogue. There are several instances in which only a single virus is shown in an antigenic group. That is so because one or more antigenic relatives of that virus have not been registered.

It is also noted that the Bunyavirus genus represents the old Bunyamwera Supergroup to which several additional serogroups have been added. The most recent additions are the Anopheles B and Turlock serogroups. The Bunyamwera Supergroup originally was formulated to reflect low-level but reproducible intergroup relationships usually by complement-fixation and/or hemagglutination-inhibition reactions. In a somewhat analogous situation, the nairoviruses consist of 6 distinct serogroups which share low-level intergroup relationships among themselves. Registered viruses belonging in the Bunyamwera Supergroup constitute approximately one-fourth of all registered viruses.



Table 3. Initial isolations by decade and country of origin: Table 3 lists the initial isolation of specific registered viruses by the decade of discovery and according to the continent or subcontinent and country in which each was first discovered. Because of the large number of virus names involved, abbreviations are employed. These abbreviations and the associated complete names of the respective viruses may be found in Table 1.

Table 4. Initial isolation of viruses by continent, country, and chronological period: Similar data were utilized in Tables 3 and 4, though they were subjected to slightly different analyses and were presented in a different format. Periods or locations which show high numbers of virus isolation undoubtedly reflect the net effect of a number of contributing factors such as the change in emphasis of field programs from a search for viruses causing specific diseases to a systematic search for viruses, new or known, in their natural ecological niche in a given geographical area, refinements in isolation and identification techniques, improved communication between arbovirus laboratories, and more rapid dissemination of new information, as well as the presence in a given area of an arbovirus laboratory with highly active and effective field programs.

Tables 5 through 32 list registered viruses by taxon and, within taxon, by serogroup, with information regarding isolations from arthropod vectors and vertebrates, and geographic (by continent) distribution based on virus isolation. Data also are presented regarding production of disease in man in nature or by laboratory infection, evaluation of arbovirus status, and proved or provisional taxonomic status. Where possible, sets of viruses were grouped additionally according to their actual or suspected principal arthropod vector.

The data presented in these tables clearly illustrate the salient features characteristic of each set or subset of viruses. Thus, the reader is urged to carefully examine the tables for information that may be of specific interest, or that will provide an overview of the general characteristics of a given group of viruses.

Table 5. Alphaviruses: Alphaviruses clearly are mosquito associated, although a few have been isolated from other arthropods. About one-half of the alphaviruses are associated with birds, while some of them, particularly those of the VEE complex, are associated with rodents.

Eleven alphaviruses have been isolated from man while twelve have been implicated in causing human disease either by infections acquired in nature or in the laboratory. All of the latter viruses are rated as Arbovirus (11 viruses) or Probable Arbovirus (1 virus).

Thus far Getah virus has not been shown to be involved in the production of disease in man; however, in recent years it has caused an epizootic of fever and rash among race horses in Central Japan. Numerous isolations of Getah virus were obtained from infected horses; and horses experimentally inoculated with the virus developed a disease similar to that seen in nature.

Tables 6, 7, and 8. Flaviviruses: Of the 62 registered flaviviruses, 47% have been placed in the mosquito-associated category (Table 6), 24% are considered to be tick-borne (Table 7), and 29% are categorized as not being associated with a proven arthropod vector (Table 8).

Twenty-three of the 29 registered flaviviruses which are mosquito-associated (Table 6) are rated as Probable Arbovirus or Arbovirus. The tick-borne flaviviruses (Table 7) contain four registered viruses, Absettarov, Hanzalova, Hypr, and Kumlinge, which are very closely related or indistinguishable by conventional serological techniques, though they are said to be clearly differentiated on the basis of clinical, epidemiological, and ecological markers from RSSE and other members of the same complex.

With the exception of two members, none of the rest of the registered flaviviruses placed in the "no arthropod vector demonstrated" category (Table 8) are rated above Possible Arbovirus by SEAS. Seven members are rated as Probably not or Not Arbovirus. Three newly registered flaviviruses (Aroa, Sal Vieja and San Perlita viruses) have been placed in the "no arthropod vector demonstrated" category. All three viruses provisionally have been rated as Possible Arbovirus by SEAS. Sal Vieja and San Perlita viruses were isolated from rodents while Aroa virus was isolated from a sentinel hamster.

Tables 9 through 16. Bunyaviruses, Family Bunyaviridae: Sixteen antigenic sets of viruses plus Kaeng Khoi virus (SBU) comprise the bunyaviruses. This amounts to a total of 111 registered viruses being placed within the Bunyavirus genus.

Table 9. Anopheles A and Bunyamwera serogroup viruses: Members of the Anopheles A serogroup have been isolated either from Anopheline or Culicine mosquitoes, or both. Of the four members of this serogroup, only Tacaiuma virus has been reported to cause a febrile illness in man. In addition, this virus has been isolated from man and from a sentinel monkey.

Virgin River virus, which was registered within the last year, represents a new addition to the Anophles A serogroup. This virus was isolated from mosquitoes collected in Arizona, and very little is known concerning its behavior in nature.

With the exception of Main Drain virus, all other members of the Bunyamwera serogroup have been isolated from Culicine or Anopheline mosquitoes. In addition, Lokern and Main Drain viruses have been isolated from Culicoides insects. Maguari virus has been recovered from livestock, Anhembi, Gerniston and Kairi viruses from rodents, and Lokern, Main Drain and Tensaw viruses from lagomorphs.

Bunyamwera, Gerniston, Ilesha and Wyeomyia viruses have been isolated from man. In addition, these four viruses plus Colovo virus have been shown to be associated with human disease, either in nature, or by laboratory-acquired infections, or both.

Thirteen of the eighteen (72%) viruses registered in the Bunyamwera serogroup have been rated as Arbovirus or Probable Arbovirus. None are rated below Possible Arbovirus.

Members have been found most frequently in North America (8), South America (5) and Africa (4). Thus far, only one virus has been recovered in Asia, two in Europe and none in Australasia.

Table 10. Bwamba serogroup and serogroup C viruses: Both Bwamba and Pongola viruses (Bwamba serogroup) are mosquito-associated, and Bwamba virus has been isolated from man. Bwamba virus has been reported to produce a febrile illness in man as a result of infections acquired in nature. Thus far, these two viruses have been found in Africa only.

The Group C viruses have been closely associated with mosquito vectors and small animals, particularly rodents. Only Gumbo Limbo virus has not been isolated from man and with the exception of Gumbo Limbo, all other members have been associated with human febrile illness. In addition, Apeu and Oriboca viruses have been reported to infect man as a result of laboratory mishaps. Ten of these viruses have been classified as Arbovirus and one as Probable Arbovirus.

Table 11. California and Capim serogroup viruses: All the California group viruses are associated with mosquito vectors and four members have been recovered from naturally infected rodents. La Crosse, Guaroa, and Tahyna viruses have been isolated from man, and along with California encephalitis and Inkoo viruses, have been associated with disease in nature. Only Inkoo and Tahyna viruses have been isolated outside the continents of North and South America. On the basis of virus isolation, the geographic distribution of Tahyna now includes Asia as well as Africa and Europe. Within the last year, SEAS upgraded San Angelo virus from a Possible Arbovirus to an Arbovirus.

Viruses of the Capim serogroup are associated with mosquito vectors, and four of the members have been isolated from rodents. None of these eight viruses have been associated with disease in man. Capim group members have been recovered only in North and South America

Table 12. Gamboa, Guama and Koongol serogroup viruses: In addition to the registered Gamboa virus, the Gamboa serogroup contains six other antigenically well-characterized but unregistered members. Four are considered to be distinct virus types while the other three are considered to be variants. All seven viruses have been isolated only from Aedeomyia squamipennis mosquitoes.

Guama serogroup viruses have been found only in the western hemisphere. Catu and Guama viruses have been isolated from man and have been associated with disease in man infected in nature.

Both Koongol group viruses were isolated in Australia and very little is known about them.

Table 13. Minatitlan, Olifantsvlei and Patois serogroup viruses: The Minatitlan serogroup contains one registered member (MNT) and one presently unregistered virus designated as Palestina virus. Manatitlan virus was isolated from a sentinel hamster exposed near Minatitlan, Mexico. Little is known concerning its role in nature.

The Olifantsvlei group consists of three members, and all three were isolated in Africa from mosquitoes. Information on the properties of these viruses has not been readily available.

Viruses of the Patois group have been isolated only in North America, and they appear to be associated with mosquito vectors and rodent hosts. Patois, Shark River, and Zegla viruses also were isolated from sentinel hamsters.

Table 14. Simbu serogroup viruses: Almost as many Simbu group viruses have been isolated from Culicoides insects as have been isolated from mosquitoes. None have been recovered from rodents. Eight Simbu serogroup viruses have been isolated from livestock. These include Sabo, Sango, Shamonda and Shuni viruses (Nigeria), Douglas and Peaton viruses (Australia), Akabane virus (Japan and Australia) and Sathuperi virus (India and Africa). Opopouche and Shuni viruses are the only members that have been isolated from man. Oropouche virus has caused frequent large outbreaks of disease among the human population in Brazil.

Simbu group viruses have a wide distribution. Approximately 50% have been found in Africa or Africa and Asia, while others have been isolated in Asia or Asia and Australasia and North or South America.

Douglas and Tinaroo viruses are new members of the Simbu serogroup. Both viruses were isolated from Culicoides brevitarsis collected in Australia, and in addition, Douglas virus was recovered from cattle.

Table 15. Tete serogroup and unassigned (SBU) viruses: All the Tete group viruses have been recovered from birds. Only two of the members (Bahig and Matruh viruses) have been recovered from any kind of a vector, namely ixodid ticks.

As a result of recent findings, Jurona virus was removed from the unassigned (SBU) viruses and placed in the VSV serogroup. Only Kaeng Khoi virus remains as a serologically unassigned bunyavirus. Kaeng Khoi virus was isolated from bats, sentinel mice and rats, and cimicid bugs.

Table 16. Anopheles B and Turlock serogroup viruses: Studies published within the last year have shown that Turlock and Boraceia viruses have virion RNA species and polypeptides comparable to those of members of the Bunyavirus genus and unlike those of members of the newly defined Phlebovirus, Nairovirus or Uukuvirus genera of the Bunyaviridae family (6). In addition, competition radiimmune assays (RIA) have indicated that Boraceia and Turlock viruses share antigenic determinants with other bunyaviruses. Thus, both serogroups have been assigned to the Bunyavirus genus.

Anopheles B viruses have been isolated only from mosquitoes collected in South America. Neither virus has been associated with infections in man.

Lednice virus, isolated from mosquitoes collected in Czechoslovakia, is a new member of the Turlock serogroup. Previous members were found in Africa, Asia, Australia, and North and South America. Turlock and Umbre viruses appear to be associated with birds.

Table 17. Phlebotomus fever serogroup viruses: At present, the PHL antigenic group comprises the Phlebovirus genus within the Bunyaviridae family. Sicilian sandfly fever virus is the type virus for this genus.

The majority of the group members are associated with phlebotomine flies, while 7 of these viruses have been isolated from man or have been implicated in the production of disease in man.

The recently registered Tehran virus is a new member of the PHL serogroup. It was isolated from phlebotomine insects collected in Iran.

Rift Valley fever virus causes serious and extensive disease in domestic animals such as sheep and cattle, and may cause disease in veterinary personnel, field and laboratory workers, as well as herdsmen who handle infected animals.

Table 18. Tick-borne serogroups other than serogroup B viruses.  
Nairoviruses: Members of the six antigenic groups shown in Tables 18 and 19 constitute the newly defined Nairovirus genus in the Bunyaviridae family. CHF-Congo virus was designated the type virus for this genus. Furthermore, reproducible intergroup antigenic relationships have been demonstrated for the six sets of viruses (1). Only members of the CHF-Congo and NSD serogroups have been associated with the production of disease in man.

Crimean hemorrhagic fever virus officially was registered within the last year. It must be reiterated that Congo virus is antigenically indistinguishable from the agent of Crimean hemorrhagic fever (CHF). The latter virus has been implicated in hundreds of cases of disease in the U.S.S.R. Thus far Hazara virus has not been known to be involved in infections of man, and little is known of this antigenic relative of CHF-Congo virus.

Members of the DGK serogroup have not been isolated from vertebrate hosts, nor from arthropod vectors other than ticks. These viruses have been found in Africa, Asia and Australasia.

Only Hughes virus of the Hughes serogroup has been isolated from birds. It has been found in both North and South America while Soldado virus has been isolated in Africa, Asia and Australasia.



Table 19. Tick-borne serogroups other than serogroup B viruses:

Nairoviruses: Nairobi sheep disease virus is an important cause of veterinary disease, while both Dugbe and Ganjam viruses have been isolated repeatedly from ticks taken off from domestic animals. Dugbe and Ganjam viruses have caused febrile illnesses in man. In the case of NSD, one infection in man resulted in a febrile illness, while three others resulted in subclinical serologic conversions. Pending further clarification of antigenic relationships, SIRACA considers Gamjam virus to be a variety of NSD virus.

Both Qalyub group viruses were found only in Africa, and both have been isolated from ticks. In addition, Bandia virus has been isolated from rodents.

Except for Avalon virus, members of the Sakhalin antigenic set were isolated only from ticks. Avalon virus also was recovered from a bird. Sakhalin serogroup viruses are distributed in Asia (PMR, SAK), Australasia (TAG), Europe (CM), and North America (AVA, SAK). Antigenic studies indicate that Avalon and Paramushir viruses are strains of the same virus.

Table 20. Tick-borne serogroups other than serogroup B viruses: At present, Uukuniemi serogroup viruses constitute the Uukuvirus genus in the Bunyaviridae family. Other serogroups listed in that table remain provisionally classified as bunyavirus-like or are unclassified (QRF serogroup).

Except for Uukuniemi virus, all members of the Uukuniemi serogroup have been isolated only from ticks. Uukuniemi virus has been recovered from both rodents and birds. Two of the viruses were found in Asia while the other three were discovered in Europe. Hemagglutination-inhibition antibodies to Uukuniemi virus have been detected in the sera of human beings residing in Europe.

Two of the Kaisodi group viruses were isolated from ticks in Asia while the third was isolated in North America. None of these viruses have been found to be involved in causing infections in man. Recently described but presently unpublished studies indicate that Silverwater virus has RNA species and polypeptides which resemble those of uukuviruses (7).

Thogoto virus has been isolated from man and has been involved in the production of disease in man. A presently unregistered antigenic relative of Thogoto virus has been isolated in Sicily. Molecular analysis of a unregistered antigenic relative (Sicilian arbovirus 126) of Thogoto virus indicated that its RNA species and polypeptides resemble those of phleboviruses (7).

The Upolu serogroup consists of Upolu virus and its recently registered antigenic relative, Aransas Bay virus. Both viruses were isolated only from ticks. Neither virus has been associated with infections in man.

Quaranfil virus has been isolated from both man and rodents, and has been associated with causing disease in man infected in nature. Preliminary studies conducted with Quaranfil virus indicate that this virus induces polypeptides in infected cells similar to those induced by arenaviruses (7). Little is known concerning the behavior of Johnston Atoll virus in nature.

Table 21. Minor antigenic groups of viruses: All the viruses listed in this table are members of minor antigenic groups, and are characterized taxonomically as bunyavirus-like. Viruses of the Matariya and Nyando serogroups were provisionally classified as bunyavirus-like relatively recently. Most virus members of these minor serogroups have been primarily associated with mosquito vectors.

Bakau group viruses have been recovered only in Asia. Bakau virus has been isolated from both mosquitoes and ticks, and rodents as well. Additional information concerning these viruses is not available.

Thus far, all four viruses of the Mapputta group have been found only in Australia. Maprik virus is rated as a Probable Arbovirus while the other three virus members are classified as Possible Arbovirus.

All three Matariya group viruses have been recovered from birds collected in Africa. Nothing is known concerning their possible vector association.

Nyando virus has been isolated from a single case of febrile illness in man. It also has been isolated from mosquitoes collected in Africa.

Table 22. Tick-borne serogroups other than serogroup B viruses: While the viruses in Table 22 also are tick-borne agents, they differ taxonomically from those in Table 18-20 in that they have been classified as orbiviruses in the family Reoviridae. The orbiviruses are relatively resistant to lipid solvents, are inactivated at an acid pH, and possess multiple segments of a double stranded RNA genome.

Only Colorado tick fever virus of the CTF serogroup and Kemerovo virus of the KEM serogroup have produced disease in man and have been isolated from man.

Members of the Kemerovo group are widely distributed with at least one virus being found in each of the listed continents. Kemerovo virus has been found in both Africa and Asia while Wad Medani virus has been discovered in Africa, Asia and North America.

Tables 23, 24. Minor antigenic groups of viruses: Members of these minor antigenic groups have been characterized and taxonomically classified as orbiviruses.

Several of the viruses in these minor antigenic groups are important in causing disease in large animals. Bluetongue virus causes disease in both wild and domestic ruminants; AHS virus in mules, donkeys and horses; and EHD virus in deer. Both bluetongue and AHS viruses have a wide geographic distribution.

Changuinola virus is the only member from these minor antigenic groups which has been isolated from man, and has been reported to produce disease in man. Of the present seven serogroup members, only Irituia virus has not been isolated from an arthropod. All others, including Changuinola virus, appear to be associated with phlebotomine insects.

Virus members of the Corriparta, Eubenangee, and Palyam serogroups appear to primarily mosquito-associated, while members of the Wallal and Warrego serogroup appears to be associated with Culicoides insects.

Table 25. Minor antigenic groups of viruses: Members of the serogroups listed in this table possess a "bullet-shaped" morphology and are classified as rhabdoviruses.

All of the present Hart Park serogroup members are associated with a mosquito vector and two of the viruses (Hart Park and Flanders) have been isolated from birds. None of these viruses have been associated with disease in man. Thus far, their distribution includes only North and South America.

The Kwatta virus was isolated only once from mosquitoes collected in Surinan. The antigenic relative of Kwatta virus remains unregistered. This unregistered virus was recovered from birds in Brazil. Very little additional is known of the two Mossuril serogroup viruses. Both were isolated from mosquitoes collected in Africa and, in addition, Mossuril virus also was isolated from birds. All three viruses of the Sawgrass serogroup were isolated from ticks in North America. Both viruses of the Timbo serogroup were isolated from lizards, and neither virus was ever isolated from arthropods.

The VSV serogroup now consists of eight rhabdoviruses. Jurona virus has been added as a new antigenic member. Formerly, it had been an unassigned virus in the Bunyamwera Supergroup (SBU). Electron microscopic and serologic studies have demonstrated that it has typical rhabdovirus morphology, and that it was related by CF, NT and IFA to members of the VSV antigenic group (4,11). Three VSV group members have been isolated from phlebotomine flies, and two others have been isolated from mosquitoes. Of the serogroups listed in this table, only members of the VSV serogroup have been implicated in causing infections of man. Chandipura, Piry, VS-Indiana, and VS-New Jersey have been isolated from man, while the former viruses plus VS-Alagoas have been found to produce disease in man during infections acquired in nature or in the laboratory. Both VS-Indiana and VS-New Jersey viruses readily infect livestock, while Cocal virus has been recovered from a horse and VS-Alagoas virus from a mule.

Table 26. Minor antigenic groups of viruses: These antigenic groups consist of members which are taxonomically unclassified.

Both Boteke group viruses have been isolated in Africa only. Zingilamo virus was recovered from a bird and Boteke virus was isolated from mosquitoes. Recently published studies have indicated that Zingilamo virus resembles Togaviridae (13). Pending further information, both viruses of this serogroup will be listed as unclassified in this Annual Report.

Malakal and Puchong viruses (Malakal serogroup) have been isolated from mosquitoes only. Malakal virus was recovered from mosquitoes collected in Africa, while Puchong virus was found in Asia.

Both Marburg and Ebola viruses cause human disease in nature and have been associated with laboratory-acquired infections. Ebola virus recently was found to possess a single-stranded RNA which was non-infectious upon extraction.

The two viruses of the Tanjong Rabok serogroup have been isolated in Malaysia and neither has been associated with a vector. Telok Forest virus was isolated from a wild monkey and Tanjong Rabok virus from a sentinel monkey.

Table 27. Tacaribe group viruses: Tacaribe group viruses are serologically related to lymphocytic choriomeningitis virus, and they are classified taxonomically in the Arenavirus genus. They are primarily rodent viruses, and there is little or no evidence that they are associated with an arthropod vector in nature. SEAS has judged all members to be nonarthropod-borne.

Three members of this group have been implicated in severe, often fatal human disease. These include Junin (Argentina hemorrhagic fever), Machupo (Bolivian hemorrhagic fever), and Lassa (Lassa disease). In addition to causing overt laboratory-acquired infections, Junin virus also has been reported to cause subclinical laboratory-acquired infections. A subclinical seroconversion to Tacaribe virus has been documented in a laboratory worker handling large quantities of Tacaribe virus. In addition, Pichinde virus has produced subclinical infections in laboratory workers.

Table 28. Ungrouped mosquito-associated viruses: The viruses in this table are serologically ungrouped, though they have been clustered together on the basis of their association with a mosquito vector and placed into subsets according to their taxonomic classification. Of those placed in the bunyavirus-like category, two of the African viruses are known to infect man. Both Tataguine and Zinga viruses have been isolated from man, and both have been reported to produce disease in man during the course of infections acquired in nature. Recent electron microscopic studies have indicated that Pacora virus resembles a typical bunyavirus (10). Provisionally, it has been listed with those viruses in the bunyavirus-like set.

Bocas virus was formerly included in the CAL group until it was demonstrated that it was identical to or closely related to mouse hepatitis virus.

Of the ungrouped orbiviruses associated with mosquito vectors, two viruses have been found in Africa (LEB, ORU), two in Australasia (JAP, PR) and three in North America (IERI, LLS, UMA). Ieri virus also has been listed with the orbiviruses as a result of recent morphologic evidence (10). Llano Seco virus is antigenically related to Umatilla virus but its relationship to other established orbivirus groups has not been resolved. Thus it and Umatilla virus have been placed with the ungrouped viruses pending a clarification of their antigenic relationships.

Orungo virus has caused human disease in nature, and Lebombo virus, or a closely related virus, has been isolated from human plasma, although it has not been associated with the causation of disease in man thus far.

The picornavirus, Nodamura virus, was isolated from wild-caught mosquitoes in Japan, and it has been demonstrated to produce disease in moths and honey bees. It also has been shown that it replicates in mosquitoes and is experimentally transmitted by mosquitoes.

Cotia virus, a poxvirus, has been reported to produce disease in man in nature. Recent morphologic studies have shown that Oubungui virus also has a poxvirus morphology (14).

Table 29. Ungrouped mosquito-associated viruses: These serologically ungrouped viruses have been associated with mosquito vectors, and the majority of them remain taxonomically unclassified. Only Bangoran and Gomoka viruses have been recovered from a source other than mosquitoes. Both were isolated from birds collected in Africa.

Table 30. Ungrouped tick-, Culicoides-, or Phlebotomus-associated viruses: Approximately one-half of the listed viruses are taxonomically unclassified. All of the bunyavirus-like agents, African swine fever virus, Barur virus, and except for Ngaingan virus, all of the unclassified viruses are associated with tick vectors. Charleville and Inhangapi viruses, both classified as rhabdoviruses, are associated with phlebotomine flies. Bovine ephemeral fever and Ngaingan viruses are associated with Culicoides insects. Bhanja virus has been documented in causing a laboratory-acquired infection. Only Bhanja, Issyk-Kul and Wanowrie viruses in this list have been isolated from man. Wanowrie virus has not been associated with human disease either in nature or as a result of a laboratory accident.

Dhori virus recently was isolated from ticks collected in Portugal. Its geographic distribution has now been expanded to include Europe as well as Africa and Asia. Formerly, the Bunyaviridae study group of the ICTV had classified Dhori virus as a member of the newly defined Nairovirus genus. Subsequently, molecular studies indicated that Dhori virus possessed 7 virion polypeptides and 7 single-stranded RNA segments with 3' end sequences (7). It is considered to be more similar to orthomyxoviruses and is no longer listed with the nairoviruses.

Tettnang virus was shown to cross-react in CF tests with mouse hepatitis virus (MHV). It remains to be determined whether it is identical or closely related to MHV or that it became contaminated with MHV subsequent to its isolation. It is also possible that it is an entirely distinct coronavirus.

Issyk-Kul and Keterah viruses have been shown to be closely related or identical by CF. The decision to designate them as either the same virus or as antigenic relatives must await results of cross-neutralization testing. Pending that decision, these viruses are being listed in the ungrouped category. Issyk-Kul virus has been isolated from the blood of a man infected in nature. The infection was classified as a febrile illness.



Table 31, 32. Ungrouped viruses, no arthropod vector known: None of the listed viruses have been isolated from an arthropod vector, and they are not rated higher than Possible Arbovirus. Several of the viruses are rated Probably not Arbovirus or Not Arbovirus. More than 50% have been isolated from rodents or birds.

Bangui virus, listed in table 31, has been isolated from man and has been reported to cause a febrile illness with rash.

Approximately forty-six percent of the viruses listed in Table 31 and 32 have been taxonomically classified.

Three of the listed rhabdoviruses are associated with bats. One of these, Lagos bat virus, is antigenically related to rabies virus. Three rhabdoviruses had been recovered in Africa, two each in North and South America and one in Australasia.

Simian hemorrhagic fever virus has produced severe disease in rhesus monkeys imported from India. Other monkey species developed disease following contact with the recently imported sick rhesus monkeys. Simian hemorrhagic fever virus has been classified by SEAS as Not Arbovirus.

A majority of the unclassified viruses shown in Table 32 appear to be bird viruses. Four viruses have been recovered from rodents, two from bats, and two others from various other vertebrates. Both Le Dantec and Hantaan viruses have been isolated from man, and have been associated with disease in man. Hantaan virus is the etiologic agent of Korean hemorrhagic fever (KHF), and either is responsible for or is antigenically closely related to the agent(s) responsible for clinically similar diseases in the USSR, Japan, Manchuria, and Eastern and Northern Europe. More than 10,000 cases have occurred in Korea alone since the disease was first recognized in that country in 1951.

Table 33 gives continental distribution of viruses in different antigenic groups on the basis of virus isolation. Most of the registered viruses are very limited in the distribution. Approximately 85% have been isolated on a single continent only, while 19 or 4.3% have been found on 3 or more continents. The largest number of viruses have been isolated in Africa.

Table 34 shows the number of viruses, according to antigenic group which have been isolated from various classes of arthropods. About fifty percent have been recovered from mosquitoes, 22% from ticks, and 16% from all other classes. Ninety-four (21%) registered viruses have never been recovered from any arthropod vector. The largest number of viruses which have been isolated from any arthropod have been recovered from a single class only (223 of 352, 91.8%).

Table 35 presents a similar type of analysis in terms of virus isolations from various classes of vertebrates. Man and rodents have provided the largest number of virus isolations. Most of the viruses isolated from vertebrates have been recovered from a single class only (180 of 259, 69.5%).

Table 36 lists the viruses in each antigenic group which cause disease in man. Approximately 24% of all registered viruses have been associated with human disease, either in nature, or by laboratory-acquired infections, or both. Members of serogroups A, B, and Bunyamwera Supergroup, which constitute 44% of all registered viruses, account for 66% of the instances of association of registered viruses with disease in man.

An analysis of the SEAS ratings for all registered viruses is presented in Table 37, and it shows that 238 (53%) registrations are rated as Possible Arbovirus. Clearly, additional data are required if we are to have a more precise rating of the arthropod-borne status of these viruses. Sufficient data are available for about 47% of all registered viruses so that 41% are rated Probable Arbovirus or Arbovirus, while 6% are rated Probably not Arbovirus or Not Arbovirus.

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Table 1

ALPHABETICAL AND TAXONOMIC LISTING OF 446 VIRUSES REGISTERED  
AS OF 31 DEC. 1981 WITH RECOMMENDED ABBREVIATIONS  
AND ANTIGENIC GROUPINGS

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
ABSETTAROV	ABS	Togaviridae	<u>Flavivirus</u>	B
ABU HAMMAD	AH	Bunyaviridae	<u>Nairovirus</u>	DGK
ACADO	ACD	Reoviridae	<u>Orbivirus</u>	COR
ACARA	ACA	Bunyaviridae	<u>Bunyavirus</u>	CAP
AFRICAN HORSESICKNESS	AHS	Reoviridae	<u>Orbivirus</u>	AHS
AFRICAN SWINE FEVER	ASF	Iridoviridae		
AGUACATE	AGU	Bunyaviridae	<u>Phlebovirus</u>	PHL
AGUA PRETA	AP	Herpesviridae		
AINO	AINO	Bunyaviridae	<u>Bunyavirus</u>	SIM
AKABANE	AKA	Bunyaviridae	<u>Bunyavirus</u>	SIM
ALENQUER	ALE	Bunyaviridae	<u>Phlebovirus</u>	PHL
ALFUY	ALF	Togaviridae	<u>Flavivirus</u>	B
ALMPIWAR	ALM	Rhabdoviridae		
ALTAMIRA	ALT	Reoviridae	<u>Orbivirus</u>	CGL
AMAPARI	AMA	Arenaviridae	<u>Arenavirus</u>	TCR
ANANINDEUA	ANU	Bunyaviridae	<u>Bunyavirus</u>	GMA
ANAHANGA	ANH	Bunyaviridae	<u>Phlebovirus</u>	PHL
ANHEMBI	AMB	Bunyaviridae	<u>Bunyavirus</u>	BUN
ANOPHELES A	ANA	Bunyaviridae	<u>Bunyavirus</u>	ANA
ANOPHELES B	ANB	Bunyaviridae	<u>Bunyavirus</u>	ANB
APEU	APEU	Bunyaviridae	<u>Bunyavirus</u>	C

Table 1 continued

NAME	ABBR.	<u>TAXONOMIC STATUS</u>		ANTI-GENIC GROUP
		FAMILY	GENUS	
APEU	APEU	Bunyaviridae	<u>Bunyavirus</u>	C
APOI	APOI	Togaviridae	<u>Flavivirus</u>	B
ARAGUARI	ARA			
ARANSAS BAY	AB	Bunyaviridae	Bunyavirus-like	UPO
ARIDE	ARI			
ARKONAM	ARK			
AROA	AROA	Togaviridae	<u>Flavivirus</u>	B
ARUAC	ARU	Rhabdoviridae		
ARUMOWOT	AMT	Bunyaviridae	<u>Phlebovirus</u>	PHL
AURA	AURA	Togaviridae	<u>Alphavirus</u>	A
AVALON	AVA	Bunyaviridae	<u>Nairovirus</u>	SAK
BAGAZA	BAG	Togaviridae	<u>Flavivirus</u>	B
BAHIG	BAH	Bunyaviridae	<u>Bunyavirus</u>	TETE
BAKAU	BAK	Bunyaviridae	Bunyavirus-like	BAK
BAKU	BAKU	Reoviridae	<u>Orbivirus</u>	KEM
BANDIA	BDA	Bunyaviridae	<u>Nairovirus</u>	QYB
BANGORAN	BGN	Rhabdoviridae		
BANGUI	BGI	Bunyaviridae	Bunyavirus-like	
BANZI	BAN	Togaviridae	<u>Flavivirus</u>	B
BARMAH FOREST	BF	Bunyaviridae	<u>Bunyavirus</u>	TUR
BARUR	BAR	Rhabdoviridae		
BATAI	BAT	Bunyaviridae	<u>Bunyavirus</u>	BUN
BATAMA	BMA	Bunyaviridae	<u>Bunyavirus</u>	TETE
BATKEN	BKN			

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
BAULINE	BAU	Reoviridae	<u>Orbivirus</u>	KEM
BEBARU	BEB	Togaviridae	<u>Alphavirus</u>	A
BELEM	BLM			
BELMONT	BEL	Bunyaviridae	Bunyavirus-like	
BENEVIDES	BVS	Bunyaviridae	<u>Bunyavirus</u>	CAP
BENFICA	BEN	Bunyaviridae	<u>Bunyavirus</u>	CAP
BERTIOGA	BER	Bunyaviridae	<u>Bunyavirus</u>	GMA
BHANJA	BHA	Bunyaviridae	Bunyavirus-like	
BIMBO	BBO			
BIMITI	BIM	Bunyaviridae	<u>Bunyavirus</u>	GMA
BIRAO	BIR	Bunyaviridae	<u>Bunyavirus</u>	BUN
BLUETONGUE	BLU	Reoviridae	<u>Orbivirus</u>	BLU
BOBAYA	BOB	Bunyaviridae	Bunyavirus-like	
BOBIA	BIA	Bunyaviridae	<u>Bunyavirus</u>	OLI
BOCAS	BOC	Coronaviridae	<u>Coronavirus</u>	
BORACEIA	BOR	Bunyaviridae	<u>Bunyavirus</u>	ANB
BOTAMBI	BOT	Bunyaviridae	<u>Bunyavirus</u>	OLI
BOTEKE	BTK			BTK
BOUBOUI	BOU	Togaviridae	<u>Flavivirus</u>	B
BOVINE EPHEMERAL FEVER	BEF	Rhabdoviridae		
BUENAVENTURA	BUE	Bunyaviridae	<u>Phlebovirus</u>	PHL
BUJARU	BUJ	Bunyaviridae	<u>Phlebovirus</u>	PHL
BUNYAMWERA	BUN	Bunyaviridae	<u>Bunyavirus</u>	BUN

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
BURG EL ARAB	BEA	Bunyaviridae	Bunyavirus-like	MTY
BUSHBUSH	BSB	Bunyaviridae	<u>Bunyavirus</u>	CAP
BUSSUQUARA	BSQ	Togaviridae	<u>Flavivirus</u>	B
BUTTONWILLOW	BUT	Bunyaviridae	<u>Bunyavirus</u>	SIM
BWAMBA	BWA	Bunyaviridae	<u>Bunyavirus</u>	BWA
CABASSOU	CAB	Togaviridae	<u>Alphavirus</u>	A
CACAO	CAC	Bunyaviridae	<u>Phlebovirus</u>	PHL
CACHE VALLEY	CV	Bunyaviridae	<u>Bunyavirus</u>	BUN
CAIMITO	CAI	Bunyaviridae	<u>Phlebovirus</u>	PHL
CALIFORNIA ENC.	CE	Bunyaviridae	<u>Bunyavirus</u>	CAL
CALOVO	CVO	Bunyaviridae	<u>Bunyavirus</u>	BUN
CANDIRU	CDU	Bunyaviridae	<u>Phlebovirus</u>	PHL
CANINDE	CAN	Reoviridae	<u>Orbivirus</u>	CGL
CAPE WRATH	CW	Reoviridae	<u>Orbivirus</u>	KEM
CAPIM	CAP	Bunyaviridae	<u>Bunyavirus</u>	CAP
CARAPARU	CAR	Bunyaviridae	<u>Bunyavirus</u>	C
CAREY ISLAND	CI	Togaviridae	<u>Flavivirus</u>	B
CATU	CATU	Bunyaviridae	<u>Bunyavirus</u>	GMA
CHACO	CHO	Rhabdoviridae		TIM
CHAGRES	CHG	Bunyaviridae	<u>Phlebovirus</u>	PHL
CHANDIPURA	CHP	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
CHANGUINOLA	CGL	Reoviridae	<u>Orbivirus</u>	CGL
CHARLEVILLE	CHV	Rhabdoviridae		



Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
CHENUDA	CNU	Reoviridae	<u>Orbivirus</u>	KEM
CHIKUNGUNYA	CHIK	Togaviridae	<u>Alphavirus</u>	A
CHILIBRE	CHI	Bunyaviridae	<u>Phlebovirus</u>	PHL
CHIM	CHIM			
CHOBAR GORGE	CG			
CLO MOR	CM	Bunyaviridae	<u>Nairovirus</u>	SAK
COCAL	COC	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
COLORADO TICK FEVER	CTF	Reoviridae	<u>Orbivirus</u>	CTF
CONGO	CON	Bunyaviridae	<u>Nairovirus</u>	CHF-CON
CONNECTICUT	CNT	Rhabdoviridae		SAW
CORRIPARTA	COR	Reoviridae	<u>Orbivirus</u>	COR
COTIA	COT	Poxviridae		
COWBONE RIDGE	CR	Togaviridae	<u>Flavivirus</u>	B
CRIMEAN HEM. FE.	CHF	Bunyaviridae	<u>Nairovirus</u>	CHF-CON
D'AGUILAR	DAG	Reoviridae	<u>Orbivirus</u>	PAL
DAKAR BAT	DB	Togaviridae	<u>Flavivirus</u>	B
DENGUE-1	DEN-1	Togaviridae	<u>Flavivirus</u>	B
DENGUE-2	DEN-2	Togaviridae	<u>Flavivirus</u>	B
DENGUE-3	DEN-3	Togaviridae	<u>Flavivirus</u>	B
DENGUE-4	DEN-4	Togaviridae	<u>Flavivirus</u>	B
DERA GHAZI KHAN	DGK	Bunyaviridae	<u>Nairovirus</u>	DGK
DHORI	DHO			
DOUGLAS	DOU	Bunyaviridae	<u>Bunyavirus</u>	SIM

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
DUGBE	DUG	Bunyaviridae	<u>Nairovirus</u>	NSD
EAST. EQUINE ENC.	EEE	Togaviridae	<u>Alphavirus</u>	A
EBOLA	EBO			MBG
EDGE HILL	EH	Togaviridae	<u>Flavivirus</u>	B
ENTEBBE BAT	ENT	Togaviridae	<u>Flavivirus</u>	B
EP. HEM. DIS.	EHD	Reoviridae	<u>Orbivirus</u>	EHD
EUBENANGEE	EUB	Reoviridae	<u>Orbivirus</u>	EUB
EVERGLADES	EVE	Togaviridae	<u>Alphavirus</u>	A
EYACH	EYA	Reoviridae	<u>Orbivirus</u>	CTF
FLANDERS	FLA	Rhabdoviridae		HP
FORT MORGAN	FM	Togaviridae	<u>Alphavirus</u>	A
FRIJOLES	FRI	Bunyaviridae	<u>Phlebovirus</u>	PHL
GAMBOA	GAM	Bunyaviridae	<u>Bunyavirus</u>	GAM
GAN GAN	GG	Bunyaviridae	Bunyavirus-like	MAP
GANJAM	GAN	Bunyaviridae	<u>Nairovirus</u>	NSD
GARBA	GAR	Bunyaviridae	Bunyavirus-like	MTY
GERMISTON	GER	Bunyaviridae	<u>Bunyavirus</u>	BUN
GETAH	GET	Togaviridae	<u>Alphavirus</u>	A
GOMOKA	GOM			
GORDIL	GOR	Bunyaviridae	<u>Phlebovirus</u>	PHL
GOSSAS	GOS			
GRAND ARBAUD	GA	Bunyaviridae	<u>Uukuvirus</u>	UUK
GRAY LODGE	GLO	Rhabdoviridae		

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
GREAT ISLAND	GI	Reoviridae	<u>Orbivirus</u>	KEM
GUAJARA	GJA	Bunyaviridae	<u>Bunyavirus</u>	CAP
GUAMA	GMA	Bunyaviridae	<u>Bunyavirus</u>	GMA
GUARATUBA	GTB	Bunyaviridae	<u>Bunyavirus</u>	GMA
GUAROA	GRO	Bunyaviridae	<u>Bunyavirus</u>	CAL
GUMBO LIMBO	GL	Bunyaviridae	<u>Bunyavirus</u>	C
GURUPI	GUR	Reoviridae	<u>Orbivirus</u>	CGL
HANTAAN	HTN			
HANZALOVA	HAN	Togaviridae	<u>Flavivirus</u>	B
HART PARK	HP	Rhabdoviridae		HP
HAZARA	HAZ	Bunyaviridae	<u>Nairovirus</u>	CHF-CON
HIGHLANDS J	HJ	Togaviridae	<u>Alphavirus</u>	A
HUACHO	HUA	Reoviridae	<u>Orbivirus</u>	KEM
HUGHES	HUG	Bunyaviridae	<u>Nairovirus</u>	HUG
HYPR	HYPR	Togaviridae	<u>Flavivirus</u>	B
IBARAKI	IBA	Reoviridae	<u>Orbivirus</u>	
ICOARACI	ICO	Bunyaviridae	<u>Phlebovirus</u>	PHL
IERI	IERI	Reoviridae	<u>Orbivirus</u>	
IFE	IFE	Reoviridae	<u>Orbivirus</u>	
ILESHA	ILE	Bunyaviridae	<u>Bunyavirus</u>	BUN
ILHEUS	ILH	Togaviridae	<u>Flavivirus</u>	B
INGWAVUMA	ING	Bunyaviridae	<u>Bunyavirus</u>	SIM
INHANGAPI	INH	Rhabdoviridae		
ININI	INI	Bunyaviridae	<u>Bunyavirus</u>	SIM

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
INKOO	INK	Bunyaviridae	<u>Bunyavirus</u>	CAL
IPPY	IPPY			
IRITUIA	IRI	Reoviridae	<u>Orbivirus</u>	CGL
ISFAHAN	ISF	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
ISRAEL TURKEY MEN.	IT	Togaviridae	<u>Flavivirus</u>	B
ISSYK-KUL	IK			
ITAITUBA	ITA	Bunyaviridae	<u>Phlebovirus</u>	PHL
ITAPORANGA	ITP	Bunyaviridae	<u>Phlebovirus</u>	PHL
ITAQUI	ITQ	Bunyaviridae	<u>Bunyavirus</u>	C
JAMANXI	JAM	Reoviridae	<u>Orbivirus</u>	CGL
JAMESTOWN CANYON	JC	Bunyaviridae	<u>Bunyavirus</u>	CAL
JAPANAUT	JAP	Reoviridae	<u>Orbivirus</u>	
JAPANESE ENC.	JE	Togaviridae	<u>Flavivirus</u>	B
JERRY SLOUGH	JS	Bunyaviridae	<u>Bunyavirus</u>	CAL
JOHNSTON ATOLL	JA			QRF
JOINJAKAKA	JOI	Rhabdoviridae		
JUAN DIAZ	JD	Bunyaviridae	<u>Bunyavirus</u>	CAP
JUGRA	JUG	Togaviridae	<u>Flavivirus</u>	B
JUNIN	JUN	Arenaviridae	<u>Arenavirus</u>	TCR
JURONA	JUR	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
JUTIAPA	JUT	Togaviridae	<u>Flavivirus</u>	B
KADAM	KAD	Togaviridae	<u>Flavivirus</u>	B
KAENG KHOI	KK	Bunyaviridae	<u>Bunyavirus</u>	SBU

Table 1 continued

NAME	ABBR.	<u>TAXONOMIC STATUS</u>		ANTI-GENIC GROUP
		FAMILY	GENUS	
KAIKALUR	KAI	Bunyaviridae	<u>Bunyavirus</u>	SIM
KAIRI	KRI	Bunyaviridae	<u>Bunyavirus</u>	BUN
KAISODI	KSO	Bunyaviridae	Bunyavirus-like	KSO
KAMESE	KAM	Rhabdoviridae		MOS
KAMMAVANPETTAI	KMP			
KANNAMANGALAM	KAN			
KAOSHUAN	KS	Bunyaviridae	<u>Nairovirus</u>	DGK
KARIMABAD	KAR	Bunyaviridae	<u>Phlebovirus</u>	PHL
KARSHI	KSI	Togaviridae	<u>Flavivirus</u>	B
KASBA	KAS	Reoviridae	<u>Orbivirus</u>	PAL
KEMEROVO	KEM	Reoviridae	<u>Orbivirus</u>	KEM
KERN CANYON	KC	Rhabdoviridae		
KETAPANG	KET	Bunyaviridae	Bunyavirus-like	BAK
KETERAH	KTR			
KEURALIBA	KEU	Rhabdoviridae		
KEYSTONE	KEY	Bunyaviridae	<u>Bunyavirus</u>	CAL
KHASAN	KHA	Bunyaviridae	Bunyavirus-like	
KLAMATH	KLA	Rhabdoviridae		
KOKOBERA	KOK	Togaviridae	<u>Flavivirus</u>	B
KOLONGO	KOL			
KOONGOL	KOO	Bunyaviridae	<u>Bunyavirus</u>	KOO
KOUTANGO	KOU	Togaviridae	<u>Flavivirus</u>	B
KOWANYAMA	KOW	Bunyaviridae	Bunyavirus-like	

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
KUMLINGE	KUM	Togaviridae	<u>Flavivirus</u>	B
KUNJIN	KUN	Togaviridae	<u>Flavivirus</u>	B
KUNUNURRA	KNA	Rhabdoviridae		
KWATTA	KWA	Rhabdoviridae		KWA
KYASANUR FOR. DIS.	KFD	Togaviridae	<u>Flavivirus</u>	B
KYZYLAGACH	KYZ	Togaviridae	<u>Alphavirus</u>	A
LA CROSSE	LAC	Bunyaviridae	<u>Bunyavirus</u>	CAL
LAGOS BAT	LB	Rhabdoviridae	<u>Lyssavirus</u>	*
LA JOYA	LJ	Rhabdoviridae		
LANDJIA	LJA			
LANGAT	LGT	Togaviridae	<u>Flavivirus</u>	B
LANJAN	LJN	Bunyaviridae	Bunyavirus-like	KSO
LASSA	LAS	Arenaviridae	<u>Arenavirus</u>	TCR
LATINO	LAT	Arenaviridae	<u>Arenavirus</u>	TCR
LEBOMBO	LEB	Reoviridae	<u>Orbivirus</u>	
LE DANTEC	LD			
LEDNICE	LED	Bunyaviridae	<u>Bunyavirus</u>	TUR
LIPOVNIK	LIP	Reoviridae	<u>Orbivirus</u>	KEM
LLANO SECO	LLS	Reoviridae	<u>Orbivirus</u>	**
LOKERN	LOK	Bunyaviridae	<u>Bunyavirus</u>	BUN

\* Rabies related

\*\* Llano Seco virus is related to Umatilla virus. Its relationship to other orbivirus serogroups has not been determined.



Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
LONE STAR	LS	Bunyaviridae	Bunyavirus-like	
LOUPING ILL	LI	Togaviridae	<u>Flavivirus</u>	B
LUKUNI	LUK	Bunyaviridae	<u>Bunyavirus</u>	ANA
MACHUPO	MAC	Arenaviridae	<u>Arenavirus</u>	TCR
MADRID	MAD	Bunyaviridae	<u>Bunyavirus</u>	C
MAGUARI	MAG	Bunyaviridae	<u>Bunyavirus</u>	BUN
MAHOGANY HAMMOCK	MH	Bunyaviridae	<u>Bunyavirus</u>	GMA
MAIN DRAIN	MD	Bunyaviridae	<u>Bunyavirus</u>	BUN
MALAKAL	MAL			MAL
MANAWA	MWA	Bunyaviridae	<u>Uukuvirus</u>	UUK
MANZANILLA	MAN	Bunyaviridae	<u>Bunyavirus</u>	SIM
MAPPUTTA	MAP	Bunyaviridae	Bunyavirus-like	MAP
MAPRIK	MPK	Bunyaviridae	Bunyavirus-like	MAP
MARBURG	MBG			MBG
MARCO	MCO	Rhabdoviridae		
MARITUBA	MTB	Bunyaviridae	<u>Bunyavirus</u>	C
MATARIYA	MTY	Bunyaviridae	Bunyavirus-like	MTY
MATRUH	MTR	Bunyaviridae	<u>Bunyavirus</u>	TETE
MATUCARE	MAT			
MAYARO	MAY	Togaviridae	<u>Alphavirus</u>	A
MELAO	MEL	Bunyaviridae	<u>Bunyavirus</u>	CAL
MERMET	MER	Bunyaviridae	<u>Bunyavirus</u>	SIM
MIDDELBURG	MID	Togaviridae	<u>Alphavirus</u>	A

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
MINATITLAN	MNT	Bunyaviridae	<u>Bunyavirus</u>	MNT
MINNAL	MIN			
MIRIM	MIR	Bunyaviridae	<u>Bunyavirus</u>	GMA
MITCHELL RIVER	MR	Reoviridae	<u>Orbivirus</u>	WAR
MODOC	MOD	Togaviridae	<u>Flavivirus</u>	B
MOJU	MOJU	Bunyaviridae	<u>Bunyavirus</u>	GMA
MONO LAKE	ML	Reoviridae	<u>Orbivirus</u>	KEM
MONT. MYOTIS LEUK.	MML	Togaviridae	<u>Flavivirus</u>	B
MORICHE	MOR	Bunyaviridae	<u>Bunyavirus</u>	CAP
MOSQUEIRO	MQO	Rhabdoviridae		HP
MOSSURIL	MOS	Rhabdoviridae		MOS
MOUNT ELGON BAT	MEB	Rhabdoviridae		
M'POKO	MPO	Bunyaviridae	<u>Bunyavirus</u>	TUR
MUCAMBO	MUC	Togaviridae	<u>Alphavirus</u>	A
MURRAY VALLEY ENC.	MVE	Togaviridae	<u>Flavivirus</u>	B
MURUTUCU	MUR	Bunyaviridae	<u>Bunyavirus</u>	C
NAIROBI SHEEP DIS.	NSD	Bunyaviridae	<u>Nairovirus</u>	NSD
NARIVA	NAR	Paramyxoviridae	<u>Paramyxovirus</u>	
NAVARRO	NAV	Rhabdoviridae		
NDUMU	NDU	Togaviridae	<u>Alphavirus</u>	A
NEGISHI	NEG	Togaviridae	<u>Flavivirus</u>	B
NEPUYO	NEP	Bunyaviridae	<u>Bunyavirus</u>	C
NEW MINTO	NM	Rhabdoviridae		SAW

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
NGAINGAN	NGA			
NIQUE	NIQ	Bunyaviridae	<u>Phlebovirus</u>	PHL
NKOLBISSON	NKO			
NODAMURA	NOD	Picornaviridae		
NOLA	NOLA	Bunyaviridae	<u>Bunyavirus</u>	SIM
NORTHWAY	NOR	Bunyaviridae	<u>Bunyavirus</u>	BUN
NTAYA	NTA	Togaviridae	<u>Flavivirus</u>	B
NUGGET	NUG	Reoviridae	<u>Orbivirus</u>	KEM
NYAMANINI	NYM			
NYANDO	NDO	Bunyaviridae	Bunyavirus-like	NDO
OKHOTSKIY	OKH	Reoviridae	<u>Orbivirus</u>	KEM
OKOLA	OKO			
OLIFANTSVLEI	OLI	Bunyaviridae	<u>Bunyavirus</u>	OLI
OMSK HEM. FEVER	OMSK	Togaviridae	<u>Flavivirus</u>	B
O'NYONG NYONG	ONN	Togaviridae	<u>Alphavirus</u>	A
ORIBOCA	ORI	Bunyaviridae	<u>Bunyavirus</u>	C
OROPOUCHE	ORO	Bunyaviridae	<u>Bunyavirus</u>	SIM
ORUNGO	ORU	Reoviridae	<u>Orbivirus</u>	
OSSA	OSSA	Bunyaviridae	<u>Bunyavirus</u>	C
OUANGO	OUA			
OUBANGUI	OUB	Poxviridae		
OUREM	OUR	Reoviridae	<u>Orbivirus</u>	CGL
PACORA	PCA	Bunyaviridae	Bunyavirus-like	

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
PACUI	PAC	Bunyaviridae	<u>Phlebovirus</u>	PHL
PAHAYOKEE	PAH	Bunyaviridae	<u>Bunyavirus</u>	PAT
PALYAM	PAL	Reoviridae	<u>Orbivirus</u>	PAL
PARAMUSHIR	PMR	Bunyaviridae	<u>Nairovirus</u>	SAK
PARANA	PAR	Arenaviridae	<u>Arenavirus</u>	TCR
PAROO RIVER	PR	Reoviridae	<u>Orbivirus</u>	
PATA	PATA	Reoviridae	<u>Orbivirus</u>	EUB
PATHUM THANI	PTH	Bunyaviridae	<u>Nairovirus</u>	DGK
PATOIS	PAT	Bunyaviridae	<u>Bunyavirus</u>	PAT
PEATON	PEA	Bunyaviridae	<u>Bunyavirus</u>	SIM
PHNOM-PEHN BAT	PPB	Togaviridae	<u>Flavivirus</u>	B
PICHINDE	PIC	Arenaviridae	<u>Arenavirus</u>	TCR
PICOLA	PIA			
PIRY	PIRY	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
PIXUNA	PIX	Togaviridae	<u>Alphavirus</u>	A
PONGOLA	PGA	Bunyaviridae	<u>Bunyavirus</u>	BWA
PONTEVES	PTV	Bunyaviridae	<u>Uukuvirus</u>	UUK
POWASSAN	POW	Togaviridae	<u>Flavivirus</u>	B
PRETORIA	PRE	Bunyaviridae	<u>Nairovirus</u>	DGK
PUCHONG	PUC			MAL
PUNTA SALINAS	PS	Bunyaviridae	<u>Nairovirus</u>	HUG
PUNTA TORO	PT	Bunyaviridae	<u>Phlebovirus</u>	PHL
QALYUB	QYB	Bunyaviridae	<u>Nairovirus</u>	QYB

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
QUARANFIL	QRF			QRF
RAZDAN	RAZ	Bunyaviridae	Bunyavirus-like	
RESTAN	RES	Bunyaviridae	<u>Bunyavirus</u>	C
RIFT VALLEY FEVER	RVF	Bunyaviridae	<u>Phlebovirus</u>	PHL
RIO BRAVO	RB	Togaviridae	<u>Flavivirus</u>	B
RIO GRANDE	RG	Bunyaviridae	<u>Phlebovirus</u>	PHL
ROCHAMBEAU	RBV			
ROCIO	ROC	Togaviridae	<u>Flavivirus</u>	B
ROSS RIVER	RR	Togaviridae	<u>Alphavirus</u>	A
ROYAL FARM	RF	Togaviridae	<u>Flavivirus</u>	B
RUSS. SPR. SUM. ENC.	RSSE	Togaviridae	<u>Flavivirus</u>	B
SABO	SABO	Bunyaviridae	<u>Bunyavirus</u>	SIM
SABOYA	SAB	Togaviridae	<u>Flavivirus</u>	B
SAGIYAMA	SAG	Togaviridae	<u>Alphavirus</u>	A
SAINT-FLORIS	SAF	Bunyaviridae	<u>Phlebovirus</u>	PHL
SAKHALIN	SAK	Bunyaviridae	<u>Nairovirus</u>	SAK
SAKPA	SPA			
SALANGA	SGA	Poxviridae		
SALEHABAD	SAL	Bunyaviridae	<u>Phlebovirus</u>	PHL
SAL VIEJA	SV	Togaviridae	<u>Flavivirus</u>	B
SAN ANGELO	SA	Bunyaviridae	<u>Bunyavirus</u>	CAL
SANDFLY F. (NAPLES)	SFN	Bunyaviridae	<u>Phlebovirus</u>	PHL
SANDFLY F. (SICILIAN)	SFS	Bunyaviridae	<u>Phlebovirus</u>	PHL

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
SANDJIMBA	SJA			
SANGO	SAN	Bunyaviridae	<u>Bunyavirus</u>	SIM
SAN PERLITA	SP	Togaviridae	<u>Flavivirus</u>	B
SANTA ROSA	SAR	Bunyaviridae	<u>Bunyavirus</u>	BUN
SATHUPERI	SAT	Bunyaviridae	<u>Bunyavirus</u>	SIM
SAUMAREZ REEF	SRE	Togaviridae	<u>Flavivirus</u>	B
SAWGRASS	SAW	Rhabdoviridae		SAW
SEBOKELE	SEB			
SELETAR	SEL	Reoviridae	<u>Orbivirus</u>	KEM
SEMBALAM	SEM			
SEMLIKI FOREST	SF	Togaviridae	<u>Alphavirus</u>	A
SEPIK	SEP	Togaviridae	<u>Flavivirus</u>	B
SERRA DO NAVIO	SDN	Bunyaviridae	<u>Bunyavirus</u>	CAL
SHAMONDA	SHA	Bunyaviridae	<u>Bunyavirus</u>	SIM
SHARK RIVER	SR	Bunyaviridae	<u>Bunyavirus</u>	PAT
SHUNI	SHU	Bunyaviridae	<u>Bunyavirus</u>	SIM
SILVERWATER	SIL	Bunyaviridae	Bunyavirus-like	KSO
SIMBU	SIM	Bunyaviridae	<u>Bunyavirus</u>	SIM
SIMIAN HEM. FE.	SHF	Togaviridae		
SINDBIS	SIN	Togaviridae	<u>Alphavirus</u>	A
SIXGUN CITY	SC	Reoviridae	<u>Orbovirus</u>	KEM
SLOVAKIA	SLO			
SNOWSHOE HARE	SSH	Bunyaviridae	<u>Bunyavirus</u>	CAL



Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
SOKOLUK	SOK	Togaviridae	<u>Flavivirus</u>	B
SOLDADO	SOL	Bunyaviridae	<u>Nairovirus</u>	HUG
SOROROCA	SOR	Bunyaviridae	<u>Bunyavirus</u>	BUN
SPONDWENI	SPO	Togaviridae	<u>Flavivirus</u>	B
ST. LOUIS ENC.	SLE	Togaviridae	<u>Flavivirus</u>	B
STRATFORD	STR	Togaviridae	<u>Flavivirus</u>	B
SUNDAY CANYON	SCA	Bunyaviridae	Bunyavirus-like	
TACAIUMA	TCM	Bunyaviridae	<u>Bunyavirus</u>	ANA
TACARIBE	TCR	Arenaviridae	<u>Arenavirus</u>	TCR
TAGGERT	TAG	Bunyaviridae	<u>Nairovirus</u>	SAK
TAHYNA	TAH	Bunyaviridae	<u>Bunyavirus</u>	CAL
TAMDY	TDY	Bunyaviridae	Bunyavirus-like	
TAMIAMI	TAM	Arenaviridae	<u>Arenavirus</u>	TCR
TANGA	TAN			
TANJONG RABOK	TR			TR
TATAGUINE	TAT	Bunyaviridae	Bunyavirus-like	
TEHRAN	TEH	Bunyaviridae	<u>Phlebovirus</u>	PHL
TELOK FOREST	TF			TR
TEMBE	TME			
TEMBUSU	TMU	Togaviridae	<u>Flavivirus</u>	B
TENSAW	TEN	Bunyaviridae	<u>Bunyavirus</u>	BUN
TERME IL	TER			
TETE	TETE	Bunyaviridae	<u>Bunyavirus</u>	TETE

Table 1 continued

NAME	ABBR.	<u>TAXONOMIC STATUS</u>		ANTI-GENIC GROUP
		FAMILY	GENUS	
TETTNANG	TET	Coronaviridae		
THIMIRI	THI	Bunyaviridae	<u>Bunyavirus</u>	SIM
THOGOTO	THO	Bunyaviridae	Bunyavirus-like	THO
THOTTAPALAYAM	TPM			
TILLIGERRY	TIL	Reoviridae	<u>Orbivirus</u>	EUB
TIMBO	TIM	Rhabdoviridae		TIM
TIMBOTEUA	TBT	Bunyaviridae	<u>Bunyavirus</u>	GMA
TINAROO	TIN	Bunyaviridae	<u>Bunyavirus</u>	SIM
TLACOTALPAN	TLA	Bunyaviridae	<u>Bunyavirus</u>	BUN
TONATE	TON	Togaviridae	<u>Alphavirus</u>	A
TOSCANA	TOS	Bunyaviridae	<u>Phlebovirus</u>	PHL
TOURE	TOU			
TRIBEC	TRB	Reoviridae	<u>Orbivirus</u>	KEM
TRINITI	TNT	Togaviridae		
TRIVITTATUS	TVT	Bunyaviridae	<u>Bunyavirus</u>	CAL
TRUBANAMAN	TRU	Bunyaviridae	Bunyavirus-like	MAP
TSURUSE	TSU	Bunyaviridae	<u>Bunyavirus</u>	TETE
TURLOCK	TUR	Bunyaviridae	<u>Bunyavirus</u>	TUR
TURUNA	TUA	Bunyaviridae	<u>Phlebovirus</u>	PHL
TYULENIY	TYU	Togaviridae	<u>Flavivirus</u>	B
UGANDA S	UGS	Togaviridae	<u>Flavivirus</u>	B
UMATILLA	UMA	Reoviridae	<u>Orbivirus</u>	
UMBRE	UMB	Bunyaviridae	<u>Bunyavirus</u>	TUR

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
UNA	UNA	Togaviridae	<u>Alphavirus</u>	A
UPOLU	UPO	Bunyaviridae	Bunyavirus-like	UPO
URUCURI	URU	Bunyaviridae	<u>Phlebovirus</u>	PHL
USUTU	USU	Togaviridae	<u>Flavivirus</u>	B
UTINGA	UTI	Bunyaviridae	<u>Bunyavirus</u>	SIM
UUKUNIEMI	UUK	Bunyaviridae	<u>Uukuvirus</u>	UUK
VELLORE	VEL	Reoviridae	<u>Orbivirus</u>	PAL
VEN. EQUINE ENC.	VEE	Togaviridae	<u>Alphavirus</u>	A
VENKATAPURAM	VKT			
VIRGIN RIVER	VR	Bunyaviridae	<u>Bunyavirus</u>	ANA
VS-ALAGOAS	VSA	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
VS-INDIANA	VSI	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
VS-NEW JERSEY	VSNJ	Rhabdoviridae	<u>Vesiculovirus</u>	VSV
WAD MEDANI	WM	Reoviridae	<u>Orbivirus</u>	KEM
WALLAL	WAL	Reoviridae	<u>Orbivirus</u>	WAL
WANOWRIE	WAN			
WARREGO	WAR	Reoviridae	<u>Orbivirus</u>	WAR
WESSELSBRON	WSL	Togaviridae	<u>Flavivirus</u>	B
WEST. EQUINE ENC.	WEE	Togaviridae	<u>Alphavirus</u>	A
WEST NILE	WN	Togaviridae	<u>Flavivirus</u>	B
WHATAROA	WHA	Togaviridae	<u>Alphavirus</u>	A
WITWATERSAND	WIT	Bunyaviridae	Bunyavirus-like	
WONGAL	WON	Bunyaviridae	<u>Bunyavirus</u>	KOO

Table 1 continued

NAME	ABBR.	TAXONOMIC STATUS		ANTI-GENIC GROUP
		FAMILY	GENUS	
WONGORR	WGR			
WYEOMYIA	WYO	Bunyaviridae	<u>Bunyavirus</u>	BUN
YACAABA	YAC			
YAQUINA HEAD	YH	Reoviridae	<u>Orbivirus</u>	KEM
YATA	YATA	Rhabdoviridae		
YELLOW FEVER	YF	Togaviridae	<u>Flavivirus</u>	B
YOGUE	YOG			
ZALIV TERPENIYA	ZT	Bunyaviridae	<u>Uukuvirus</u>	UUK
ZEGLA	ZEG	Bunyaviridae	<u>Bunyavirus</u>	PAT
ZIKA	ZIKA	Togaviridae	<u>Flavivirus</u>	B
ZINGA	ZGA	Bunyaviridae	Bunyavirus-like	
ZINGILAMO	ZGO			BTK
ZIRQA	ZIR	Bunyaviridae	<u>Nairovirus</u>	HUG

Table 2. Antigenic Groups of 446 Viruses Registered in Catalogue

Virus Family and Genus	Antigenic Group	Abbreviation	No. Registered Viruses in Group	%
<u>ARENAVIRIDAE</u> <u>Arenavirus</u>	Tacaribe	TCR	9	2.0
<u>BUNYAVIRIDAE</u> <u>Bunyavirus</u>	Bunyamwera Supergroup		111	24.9
	Anopheles A	ANA	4	
	Anopheles B	ANB	2	
	Bunyamwera	BUN	18	
	Bwamba	BWA	2	
	C	C	11	
	California	CAL	13	
	Capim	CAP	8	
	Gamboa	GAM	1	
	Guama	GMA	10	
	Koongol	KOO	2	
	Minatitlan	MNT	1	
	Olifantsvlei	OLI	3	
	Patois	PAT	4	
	Simbu	SIM	21	
	Tete	TETE	5	
	Turlock	TUR	5	
	Unassigned	SBU	1	
<u>Nairovirus</u>	CHF-Congo	CHF-CON	3	0.7
	Dera Ghazi Khan	DGK	5	1.7
	Hughes	HUG	4	0.9
	Nairobi sheep disease	NSD	3	0.7
	Qalyub	QYB	2	0.4
	Sakhalin	SAK	5	1.1
<u>Phlebovirus</u>	Phlebotomus fever	PHL	30	6.7

Table 2 continued

Virus Family and Genus	Antigenic Group	Abbreviation	No. Registered Viruses in Group	%
BUNYAVIRIDAE				
<u>Uukuvirus</u>	Uukuniemi	UUK	5	1.1
"Bunyavirus-like"	Bakau	BAK	2	0.4
(Unassigned, probable	Kaisodi	KSO	3	0.7
or possible members)	Mapputta	MAP	4	0.9
	Matariya	MTY	3	0.7
	Nyando	NDO	1	0.2
	Thogoto	THO	1	0.2
	Upolu	UPO	2	0.4
	Ungrouped		14	3.1
REOVIRIDAE				
<u>Orbivirus</u>	African horsesickness	AHS	1	0.2
	Bluetongue	BLU	1	0.2
	Changuinola	CGL	7	1.6
	Colorado tick fever	CTF	2	0.4
	Corriparta	COR	2	0.4
	Epizootic hemorrhagic dis.	EHD	1	0.2
	Eubenangee	EUB	3	0.7
	Kemerovo	KEM	16	3.6
	Palyam	PAL	4	0.9
	Wallal	WAL	1	0.2
	Warrego	WAR	2	0.4
	Ungrouped		9	2.0
RHABDOVIRIDAE				
<u>Vesiculovirus</u>	Vesicular stomatitis	VSV	8	1.8
<u>Lyssavirus</u>	*		1	0.2
Unassigned or	Hart Park	HP	3	0.7
possible members	Kwatta	KWA	1	0.2
	Mossuril	MOS	2	0.4
	Sawgrass	SAW	3	0.7
	Timbo	TIM	2	0.4
	Ungrouped		18	4.0

\* Rabies related



Table 2 continued

Virus Family and Genus	Antigenic Group
TOGAVIRIDAE	
<u>Alphavirus</u>	A
Flavivirus	B
Possible members	Ungrouped
CORONAVIRIDAE	
<u>Coronavirus</u>	Ungrouped
HERPESVIRIDAE	Ungrouped
IRIDOVIRIDAE	Ungrouped
PARAMYXOVIRIDAE	
<u>Paramyxovirus</u>	Ungrouped
PICORNAVIRIDAE	Ungrouped
POXVIRIDAE	Ungrouped
UNCLASSIFIED	Boteke Malakal Marburg Tanjong Rabok Quaranfil Ungrouped
TOTAL	

Abbreviation	No. Registered Viruses in Group	%
A	25	5.6
B	62	13.9
	2	0.4
	1	0.2
	1	0.2
	1	0.2
	1	0.2
	1	0.2
	3	0.7
BTK	2	0.4
MAL	2	0.4
MBG	2	0.4
TR	2	0.4
QRF	2	0.4
	45	10.1
	466	

Table 3. Initial Isolations of Viruses by Decade and Country of Origin.

Decade	Continent	Country	Virus
1900-09	Africa	S. Africa	BLU
1910-19	Africa	Kenya	ASF,NSD
1920-29	Africa	Nigeria	YF
	Europe	Scotland	LI
	N. America	U.S.A.	VSI
1930-39	Africa	Kenya	RVF
		S. Africa	AHS
		Uganda	BWA,WN
	Asia	Japan	JE
		U.S.S.R.	RSSE
	N. America	U.S.A.	EEE,SLE,WEE
	S. America	Venezuela	VEE
1940-49	Africa	Uganda	BUN,NTA,SF,UGS,ZIKA
	Asia	Japan	NEG
		U.S.S.R.	OMSK
	Australasia	Hawaii	DEN-1*
		New Guinea	DEN-2*
	Europe	Czechoslovakia	HAN
		Italy	SFN*,SFS*
	N. America	U.S.A.	CE,CTF,TVT
	S. America	Brazil	ILH
		Colombia	ANA,ANB,WYO
1950-59	Africa	Egypt	CNU,QRF,QYB,SIN,WM
		Nigeria	ILE,LB
		S. Africa	BAN,GER,ING,LEB,MID,MOS,NDU,NYM, PGA,SIM,SPO,TETE,USU,WIT,WSL
		Uganda	CHIK,CON,ENT,NDO,ONN,ORU
		India	ARK,BHA,GAN,KAS,KSO,KFD,MIN,PAL, SAT,VKT,UMB,WAN
	Asia	Israel	IT
		Japan	AKA,APOI,IBA,NOD,SAG,TSU
		Malaya	BAK,BAT,BEB,GET,KET,LGT,TMU
		Australia	MVE
		Philippines	DEN-3*,DEN-4*
	Europe	Czechoslovakia	HYPR,TAH
		Finland	KUM
		U.S.S.R.	ABS
	N. America	Canada	POW
		Panama	BOC,LJ,PCA
		U.S.A.	CV,EHD,HP,MML,MOD,RB,SA,SSH,TUR,VSNJ
	S. America	Argentina	JUN
		Brazil	APEU,AURA,BSQ,CAP,CAR,CATU,GJA,GMA, ITQ,MAG,MIR,MOJU,MTB,MUC,MUR,ORI, TCM,UNA
		Colombia	GRO,NAV
		Trinidad	ARU,BIM,BSB,IERI,KRI,LUK,MAN,MAY, MEL,NEP,ORO,TCR,TNT

\* Isolated in U.S.A. Laboratory

Table 3. (Continued)

Decade	Continent	County	Virus
1960-69	Africa	Cameroon	NKO, OKO
		Cent. Afr. Rep.	BAG, BGN, BIA, BIR, BOT, BOU, BTK, MPO PATA, YATA, ZGA
		Egypt	ACD, AMT, BAH*, BEA, MTR, MTY, RF
		Kenya	THO
		Nigeria	DUG, LAS*, SABO, SAN, SHA, SHU
		Senegal	BDA, DB, GOS, KEU, KOU, LD, SAB, TAT, TOU, YOG
		South Africa	OLI
		Sudan	MAL***
		Uganda	KAD, KAM, MEB, TAN
	Asia	Cambodia	PPB
		India	BAR, CHP, DHO, KAN, KMP, SEM, THI, TPM, VEL
		Iran	KAR*, SAL*, TEH*
		Japan	AINO
		Malaysia	JUG, KTR, LJN, PUC, TR
		Pakistan (West)	DGK, HAZ, MWA
		Persian Gulf	ZIR
		Singapore	SEL
		Thailand	KK
		U.S.S.R.	CHF, KYZ, OKH, SAK, TYU, ZT
	Australasia	Australia	ALF, ALM, BEF, BEL, CHV, COR, DAG, EH, EUB, JAP, JOI, KOK, KOO, KOW, KUN, MAP, MPK, MR, RR, SEP, STR, TRU, UPO, WAR, WON
		New Zealand	WHA
		Pacific Island	JA*
	Europe	Czechoslovakia	CVO, KEM, LED, LIP, TRB
		Finland	INK, UUK
		France	GA, PTV
		West Germany	MBG
	N. America	Canada	SIL
		Guatemala	JUT*
		Mexico	MNT, TLA*
		Panama	AGU, CHG, CHI, CGL, FRI, GAM, JD, LAT, MAD, MAT, OSSA, PAR, PAT, PT*, ZEG
		U.S.A.	BUT, CR, EVE, FLA, GL, HJ, HUG, JC, JS, KC, KEY, KLA, LAC, LOK, LS, MER, MD, MH, ML, PAH, SAW, SC, SHF, SR, TAM, TEN, UMA
	S. America	Bolivia	MAC**
		Brazil	ACA, AMA, AMB, ANH, ANU, AP, ARA, BEN, BER, BLM, BOR, BUJ, BVS, CAN, CDU, CHO, COT, GTB, GUR, ICO, INH, IRI, ITP, JUR, MCO, OUR, PAC, PIRY, PIX, SDN, SOR, TBT, TIM, TME, URU, UTI, VSA
		Colombia	BUE, PIC
		French Guiana	CAB
		Peru	HUA*, PS*
		Surinam	KWA
		Trinidad	COC, MOR, NAR, RES, SOL

\* Isolated in U.S.A. laboratory

\*\* Isolated in Panama laboratory

\*\*\* Isolated in Egypt laboratory

Table 3, (Continued)

Decade	Continent	Country	Virus
1970-79	Africa	Cent.Afr.Rep.	BBO,BGI,BMA,BOB,GAR,GOM,GOR,IPPY,KOL,LJA, NOLA,OUA,OUB,SAF,SEB,SGA,SJA,SPA,ZGO
		Egypt	AH,KS,PTH
		Nigeria	IFE
		Seychelles	ARI***
		S. Africa	PRE***
	Asia	Zaire	EBO
		India	CG,KAI
		Iran	ISF*
		Korea	HTN
		Malaysia	CI,TF
	Australasia	U.S.S.R.	BKN,CHIM,IK,KHA,KSI,PMR,RAZ,SOK,TDY
		Australia	BF,DOU,GG,KNA,NGA,NUG,PEA,PIA,PR,SRE,TAG, TER,TIL,TIN,WAL,WGR,YAC
	Europe	Czechoslovakia	SLO
		Germany	EYA,TET
		Italy	TOS
		Scotland	CM,CW
		U.S.S.R.	BAKU
	N. America	Canada	AVA,BAU*,GI*
		Mexico	SAR*
		Panama	CAC,CAI,NIQ
		U.S.A.	AB,CNT,FM,GLO,LLS,NM,NOR,RG,SCA,SP,SV, VR,YH
	S. America	Brazil	ALE,ALT,ITA,JAM,MQO,ROC,TUA
		French Guiana	INI,RBU,TON
		Venezuela	AROA

\* Isolated in U.S.A. laboratory

\*\* Isolated in Panama laboratory

\*\*\* Isolated in Egypt laboratory

Table 4. Initial Isolation of 446 Registered Viruses  
by Continent, Country, and Chronological Period.

Continent	Country or Area	Before 1930	1930 -39	1940 -49	1950 -59	1960 -69	1970 -79	Totals
AFRICA	Cameroon					2		2
	Cent.Afr.Rep.					11	19	30
	Egypt				5	7	3	15
	Kenya	2	1			1		4
	Nigeria	1			2	6	1	10
	Senegal					10		10
	Seychelles						1	1
	S. Africa	1	1		15	1	1	19
	Sudan					1		1
	Uganda		2	5	6	4		17
	Zaire						1	1
	Totals	4	4	5	28	43	26	110
ASIA	Cambodia					1		1
	India				12	9	2	23
	Iran					3	1	4
	Israel				1			1
	Japan		1	1	6	1		9
	Korea						1	1
	Malaysia				7	5	2	14
	W. Pakistan					3		3
	Persian Gulf					1		1
	Singapore					1		1
	Thailand					1		1
	U.S.S.R.(East)		1	1		6	9	17
	Totals	0	2	2	26	31	15	76
AUSTRAL- ASIA and PACIFIC ISLANDS	Australia				1	25	17	43
	Hawaii			1				1
	Johnston Island					1		1
	New Guinea			1				1
	New Zealand					1		1
	Philippines				2			2
	Totals	0	0	2	3	27	17	49
EUROPE	Czechoslovakia			1	2	5	1	9
	Finland				1	2		3
	France					2		2
	West Germany					1	2	3
	Italy			2			1	3
	Scotland	1					2	3
	U.S.S.R.(West)				1		1	2
	Totals	1	0	3	4	10	7	25
NORTH AMERICA	Canada				1	1	3	5
	Guatemala					1		1
	Mexico					2	1	3
	Panama				3	15	3	21
	U.S.A.	1	3	3	10	27	13	57
	Totals	1	3	3	14	46	20	87
SOUTH AMERICA	Argentina				1			1
	Bolivia					1		1
	Brazil			1	18	37	7	63
	Colombia			3	2	2		7
	French Guiana					1	3	4
	Peru					2		2
	Surinam					1		1
	Trinidad				13	5		18
	Venezuela		1				1	2
	Totals	0	1	4	34	49	11	99
	Grand Totals	6	10	19	109	206	96	446

Table 5. Alphaviruses, Family Togaviridae

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS					VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection			
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
		Culicine	Anopheline																					
Aura	+																	+		22	Alphavirus			
Bebaru	+																			22	"			
Cabassou	+									+								+		21	"			
Chikungunya	+						+	+		+								+	+	20	"			
Eastern equine enc.	+	+			+	+	+	+	+	+	+					+	+	+	+	20	"			
Everglades	+	+						+			+						+	+		20	"			
Fort Morgan						+				+							+			20	"			
Getah	+	+															+			20	"			
Highlands J	+									+							+			20	"			
Kyzylagach	+												+				+			22	"			
Mayaro	+					+	+					+					+	+		20	"			
Middelburg	+																			20	"			
Mucambo	+						+		+	+	+		+				+	+		20	"			
Ndumu	+											+								21	"			
O'nyong-nyong			+				+							+				+		20	"			
Pixuna	+	+						+										+	+	22	"			
Ross River	+						+			+		+							+	20	"			
Sagiyama	+																			21	"			
Semliki Forest	+	+					+			+				+					+	20	"			
Sindbis	+	+	+			+	+			+						+		+		20	"			
Tonate	+	+					+			+								+	+	21	"			
Una	+	+										+					+	+		21	"			
Venezuelan equine enc.	+	+					+		+		+						+	+	+	20	"			
Western equine enc.	+	+					+		+	+						?	+	+	+	20	"			
Whataroa	+																			20	"			

- \* 20 = Arbovirus  
 21 = Probable Arbovirus  
 22 = Possible Arbovirus  
 23 = Probably not Arbovirus  
 24 = Not Arbovirus

Table 6. Mosquito-Borne Flaviviruses, Family Togaviridae

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE	SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America			Natural Infection	Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Anopheline	Ixodid																					
Alfuy	+									+												20	Flavivirus	
Bagaza	+													+								22	"	
Banzi	+						+															20	"	
Bouboui	+	+						+														22	"	
Bussuquara	+						+		+								+	+		+		20	"	
Dengue-1	+						+										+	+		+		20	"	
Dengue-2	+						+	+									+	+		+		20	"	
Dengue-3	+						+										+	+		+		20	"	
Dengue-4	+						+										+	+		+		20	"	
Edge Hill	+	+																				20	"	
Ilheus	+						+							+			+	+		+		20	"	
Japanese encephalitis	+	+					+				+		+					+		+		20	"	
Jugra	+										+											22	"	
Kokobera	+																+	+				21	"	
Kunjin	+						+										+	+		+		20	"	
Murray Valley enc.	+						+															20	"	
Ntaya	+															+						21	"	
Rocio	+						+										+	+		+		20	"	
Sepik	+																	+		+		21	"	
St. Louis encephalitis	+	+				+	+				+		+				+	+		+		20	"	
Spondweni	+						+											+		+		20	"	
Stratford	+																					22	"	
Tembusu	+	+																+		+		21	"	
Uganda S	+																					20	"	
Usutu	+														+							22	"	
Wesselsbron	+	+					+		+				+					+		+		20	"	
West Nile	+	+	+	+			+		+		+		+					+		+		20	"	
Yellow fever	+		+				+	+					+					+		+		20	"	
Zika	+						+											+		+		20	"	

\* See footnote Table 5



[illegible]

53

Table 8. Flaviviruses, Family Togaviridae:  
No Arthropod Vector Demonstrated

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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\* See footnote Table 5

Table 9. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Anopheles A and Bunyamwera Serogroup Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS													
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection												
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels										
		Culicine	Anopheline																						Ixodid	Argasid								
<u>ANOPHELES A GROUP</u>																																		
Anopheles A		+																						21	Bunyavirus									
Lukuni	+	+												+									+		22	"								
Tacaiuma	+	+						+	+															+		21	"							
Virgin River	+																							+		22	"							
<u>BUNYAMWERA GROUP</u>																																		
Anhembi	+									+																22	Bunyavirus							
Batai	+	+															+									21	"							
Birao		+														+										22	"							
Bunyamwera	+							+															+			20	"							
Cache Valley	+	+																								20	"							
Calovo**		+																								21	"							
Germiston	+							+		+				+	+								+			20	"							
Ilesha		+						+							+	+							+			21	"							
Kairi	+								+	+					+								+			20	"							
Lokern	+						+								+								+			20	"							
Maguari	+	+													+	+							+			20	"							
Main Drain							+								+											20	"							
Northway	+														+								+			21	"							
Santa Rosa	+																						+			22	"							
Sororoca	+																						+			22	"							
Tensaw	+	+												+	+								+			20	"							
Tlacotalpan	+	+																					+			22	"							
Wyeomyia	+	+						+															+			21	"							

\* See footnote Table 5

\*\* May be strain of Batai

Table 10. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Bwamba Serogroup and Serogroup C Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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Table 11. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, California and Capim Serogroup Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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\* See footnote Table 5

Table 12. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Gamboa, Guama and Koongol Serogroup Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Culicine	Anopheline																					
<u>GAMBOA GROUP</u> Gamboa	+																+				22	Bunyavirus		
<u>GUAMA GROUP</u> Ananindeua	+								+	+		+		+				+	+	+		21	Bunyavirus	
Bertioga														+				+	+	+		22	"	
Bimiti	+								+			+		+				+	+	+		20	"	
Catu	+	+					+		+		+	+		+				+	+	+		20	"	
Guama	+			+			+		+		+	+		+				+	+	+		20	"	
Guaratuba	+								+					+					+			21	"	
Mahogany Hammock	+								+								+		+			22	"	
Mirim	+								+					+					+			20	"	
Moju	+								+			+		+					+			20	"	
Timboteua									+					+					+			21	"	
<u>KOONGOL GROUP</u> Koongol	+	?																				21	Bunyavirus	
Wongal	+																+	+				21	"	

\* See footnote Table 5

Table 13. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Minatitlan, Olifantsvlei and Patois Sergroup Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE	SEAS RATING*	TAXONOMIC STATUS					
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America			Natural Infection	Lab Infection			
	Mosq.		Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
	Culicine	Anopheline	Ixodid	Argasid																					
<u>MINATITLAN GROUP</u> Minatitlan															+							22	Bunyavirus		
<u>OLIFANTSVLEI GROUP</u> Botambi Bobia Olifantsvlei	+																					22 22 22	Bunyavirus " "		
<u>PATOIS GROUP</u> Pahayokee Patois Shark River Zegla	+	+																				22 20 21 22	Bunyavirus " " "		

\* See footnote Table 5

Table 14. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Simbu Serogroup Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS					VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection			
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
		Culicine	Anopheline																					
Aino	+																			22	Bunyavirus			
Akabane	+																			21	"			
Buttonwillow														+						20	"			
Douglas																	+			21	"			
Ingwavuma	+																			20	"			
Inini																				22	"			
Kaikalur	+																	+		22	"			
Manzanilla								+										+		22	"			
Mermet																	+			22	"			
Nola	+																			20	"			
Oropouche	+							+					+					+	+	21	"			
Peaton																	+			21	"			
Sabo																				22	"			
Sango	+																			22	"			
Sathuperi	+																			22	"			
Shamonda																				22	"			
Shuni	+																		+	22	"			
Simbu	+																			21	"			
Thimiri																				22	"			
Tinaroo																				22	"			
Utinga																				22	"			

\* See footnote Table 5



Table 15. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Tete Serogroup and Unassigned Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Anopheline	Culicine																					
<u>TETE GROUP</u> Bahig Batama Matruh Tete Tsuruse			+							+	+	+	+								21 22 22 22 22	Bunyavirus " " " "		
<u>UNASSIGNED - "SBU"</u> Kaeng Khoi						+					+			+							22	Bunyavirus		

\* See footnote Table 5

Table 16. Bunyaviruses, Family Bunyaviridae:  
Bunyamwera Supergroup, Anopheles B and Turlock Serogroup Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS						VERTEBRATES					Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection			
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
		Anopheline	Ixodid																					
	Culicine																							
<u>ANOPHELES B GROUP</u> Anopheles B Boraceia	+	+																++			22 22	Bunyavirus "		
<u>TURLOCK GROUP</u> Barmah Forest Lednice M'Poko (=Yaba-1) Turlock Umbre	+	+												+		+					22 21 22 20 21	Bunyavirus " " " "		

\* See footnote Table 5

Table 17. Phleboviruses, Family Bunyaviridae:  
Phlebotomus Fever Serogroup Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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\* See footnote Table 5

Table 18. Nairoviruses, Family Bunyaviridae:  
Tick-Borne Serogroups Other Than Serogroup B Viruses

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS		
	ARTHROPODS						VERTEBRATES							Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection	
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other											Sentinels
		Anopheline	Ixodid																					
<u>CHF-CONGO GROUP</u> Congo Crimean Hem. Fe. Hazara			+	+	+								+								+	+	20 20 22	Nairovirus " "
<u>DERA GHAZI KHAN GROUP</u> Abu Hammad Dera Ghazi Khan Kao Shuan Pathum Thani Pretoria			+	+																			22 22 22 22	Nairovirus " " " "
<u>HUGHES GROUP</u> Hughes Punta Salinas Soldado Zirqa			+	+					+										+	+	+		21 22 20 22	Nairovirus " " "

\* See footnote Table 5

Table 19. Nairoviruses, Family Bunyaviridae:  
Tick-Borne Serogroups Other Than Serogroup B Viruses

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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\* See footnote Table 5

Table 20. Uukuviruses, Bunyavirus-Like, Family Bunyaviridae; Unclassified Viruses:  
Tick-Borne Serogroups Other Than Serogroup B Viruses

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES							Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other											Sentinels	
		Culicine	Anopheline																						Ixodid
UUKUNIEMI GROUP Grand Arbaud Manawa Ponteves Uukuniemi Zaliv Terpeniya				+	+	+																	20 22 22 21 22	Uukuvirus " " " "	
KAISODI GROUP Kaisodi Lanjan Silverwater				+	+	+				+					+									22 22 21	Bunyavirus-like " "
THOGOTO GROUP Thogoto				+										+				+			+			22	Bunyavirus-like
UPOLU GROUP Aransas Bay Upolu					+	+													+					22 22	Bunyavirus-like "
QUARANFIL GROUP Johnston Atoll Quaranfil					+	+								+						+				20 20	Unclassified "

\* See footnote Table 5

Table 21. Bunyavirus-Like Viruses, Family Bunyaviridae:  
Minor Antigenic Groups of Viruses

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS		
	ARTHROPODS						VERTEBRATES							Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection	
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other											Sentinels
		Culicine	Anopheline																					
BAKAU GROUP Bakau Katapang	+	+		+				+									+	+					22 21	Bunyavirus-like "
MAPPUTTA GROUP Gan Gan Mapputta Maprik Trubanaman	+																						22 22 21 22	Bunyavirus-like " " "
MATARIYA GROUP Burg el Arab Garba Matariya										+	+	+					+	+	+				22 22 22	Bunyavirus-like " "
NYANDO GROUP Nyando		+						+									+				+		21	Bunyavirus-like

\* See footnote Table 5

Table 22. Orbiviruses, Family Reoviridae:  
Tick-Borne Serogroups Other Than Serogroup B Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
	ARTHROPODS					VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
		Anopheline	Ixodid																						Argasid																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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\* See footnote Table 5



Table 23. Orbiviruses, Family Reoviridae:  
Minor Antigenic Groups of Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Anopheline	Ixodid																					
	Culicine																							
<u>AFRICAN HORSESICKNESS</u> African Horsesickness					+								+		+		+					20	Orbivirus	
<u>BLUETONGUE GROUP</u> Bluetongue					+								+		+	+	+					20	Orbivirus	
<u>CHANGUINOLA GROUP</u> Altamira Caninde Changuinola Gurupi Irituia Jamanxi Ourem					+			+		+								+	+	+	+	22 22 21 22 22 22 22	Orbivirus " " " " " "	
<u>CORRIPARTA GROUP</u> Acado Corriparta	+	+								+					+		+					22 21	Orbivirus "	
<u>EHD GROUP</u> Epizootic hem. dis.													+		+		+					21	Orbivirus	

\* See footnote Table 5

Table 24. Orbiviruses, Family Reoviridae:  
Minor Antigenic Groups of Viruses

VIRUS	ISOLATED FROM														ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS	
	ARTHROPODS						VERTEBRATES								Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection
	Mosq.	Ticks	Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other	Sentinels											
														Culicine										
<u>EUBENANGEE GROUP</u> Eubenangee Pata Tilligerry	++ +	++ +													+		+					22 22 22	Orbivirus " "	
<u>PALYAM GROUP</u> D'Aguilar Kasba Palyam Vellore	++ ++ +				+							+					+					22 22 22 22	Orbivirus " " "	
<u>WALLAL GROUP</u> Wallal					+												+					22	Orbivirus	
<u>WARREGO GROUP</u> Mitchell River Warrego					+	+											+	+				22 22	Orbivirus "	

\* See footnote Table 5

Table 25. Family Rhabdoviridae; Vesiculoviruses, Family Rhabdoviridae:  
Minor Antigenic Groups of Viruses

VIRUS	ISOLATED FROM														ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS	
	ARTHROPODS						VERTEBRATES								Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other	Sentinels										
		Culicine	Anopheline																					
<u>HART PARK GROUP</u> Flanders Hart Park Mosqueiro	+									+	+								+			22 21 22	Rhabdoviridae " "	
<u>KWATTA GROUP</u> Kwatta	+																		+			22	Rhabdoviridae	
<u>MOSSURIL GROUP</u> Kamese Mossuril	+									+					+	+						22 22	Rhabdoviridae "	
<u>SAWGRASS GROUP</u> Connecticut New Minto Sawgrass			+	+	+													+	+	+		22 22 22	Rhabdoviridae " "	
<u>TIMBO GROUP</u> Chaco Timbo												+	+						+	+		22 22	Rhabdoviridae "	
<u>VESICULAR STOMATITIS GR.</u> Chandipura Cocal Isfahan Jurona Piry VS-Alagoas VS-Indiana VS-New Jersey	+				+		+		+			+	+	+	+	+			+	+	+	20 20 22 22 22 22 20 22	Vesiculovirus " " " " " " " "	

\* See footnote Table 5

Table 26. Taxonomically Unclassified Viruses:  
Minor Antigenic Groups of Viruses

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS	
	ARTHROPODS						VERTEBRATES							Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection
	Mosq.	Ticks	Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other	Sentinels										
<u>BOTEKE GROUP</u> Boteke Zingilamo	+								+					++							22 22	Unclassified "	
<u>MALAKAL GROUP</u> Malakal Puchong	++													+	+						22 22	Unclassified "	
<u>MARBURG GROUP</u> Ebola Marburg							++							++		+			++		23 23	Unclassified "	
<u>TANJONG RABOK GROUP</u> Tanjong Rabok Telok Forest								+					+		+						22 22	Unclassified "	

\* See footnote Table 5

Table 27. Arenaviruses, Family Arenaviridae:  
Tacaribe (LCM) Serogroup Viruses

VIRUS	ISOLATED FROM											ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS					VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection			
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
		Anopheline	Ixodid																					
Amapari						+			+				+					+	+	24	Arenavirus			
Junin						+			+					+				+	+	24	"			
Lassa									+									+	+	24	"			
Latino									+									+	+	24	"			
Machupo									+									+	+	24	"			
Parana									+									+	+	24	"			
Pichinde			+			+			+									+	+	24	"			
Tacaribe	?	?							+		+							+	+	24	"			
Tamiami									+									+	+	24	"			

\* See footnote Table 5

Table 28. Families Bunyaviridae, Coronaviridae, Reoviridae, Picornaviridae, Poxviridae:  
Ungrouped Mosquito-Associated Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Culicine	Anopheline																					
Belmont Kowanyama Pacora Tataguine Witwatersrand Zinga	+		+											+								22 22 22 21 20 22	Bunyavirus-like " " " " "	
Bocas	+										+							+	+				22	Coronavirus
Ieri Japanaut Lebombo Llano Seco** Orungo Paroo River Umatilla	+	+						+	+									+					22 21 21 21 21 22 20	Orbivirus " " " " " "
Nodamura	+																+						23	Picornavirus
Cotia Oubangui	+	+			+		+							+				+	+				24 22	Poxvirus "

\* See footnote Table 5

\*\* Although it has been demonstrated that Llano Seco virus is antigenically related to Umatilla virus, its antigenic relationship to other established orbivirus serogroups is uncertain.

Table 29. Families Rhabdoviridae; Togaviridae; Taxonomically Unclassified Viruses:  
Ungrouped Mosquito-Associated Viruses

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Anopheline	Ixodid																					
	Culicine																							
Aruac	+																	+			21	Rhabdoviridae		
Bangoran	+									+											22	"		
Gray Lodge	+																	+			22	"		
Joinjakaka	+																	+			22	"		
Kununurra	+																				22	"		
La Joya	+																	+			22	"		
Yata	+																				22	"		
Trinititi	+																	+			21	Togaviridae		
Arkonam	+	+																			22	Unclassified		
Gomoka	+	+								+											22	"		
Minnal	+																				22	"		
Nkolbisson	+																				22	"		
Okola	+																				22	"		
Picola	+																				22	"		
Rochambeau	+																				22	"		
Tanga		+																+			22	"		
Tembe		+																			22	"		
Termeil	+																	+			21	"		
Venkatapuram	+																				22	"		
Wongorr	+																				22	"		
Yacaaba	+																				22	"		

\* See footnot Table 5

Table 30. Families Bunyaviridae, Iridoviridae, Rhabdoviridae; Taxonomically Unclassified Viruses:  
Ungrouped Tick-, Culicoides-, or Phlebotomus-Associated Viruses

VIRUS	ISOLATED FROM														ISOLATED IN						HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS
	ARTHROPODS						VERTEBRATES								Africa	Asia	Australasia	Europe	North America	South America	Natural Infection	Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials	Other	Sentinels										
		Anopheline	Culicine																					
Bhanja			+				+		+				+		+	+		+			+	22	Bunyavirus-like	
Khasan			+												+	+						22	"	
Lone Star			+														+					22	"	
Razdan			+													+						22	"	
Sunday Canyon				+													+					22	"	
Tamdy				+												+						22	"	
African swine fever				+						+					+			+		+++		20	Iridoviridae	
Barur			+						+						+	+						22	Rhabdoviridae	
Bovine ephemeral fever						+							+		+							22	"	
Charleville						+						+			+							22	"	
Inhangapi				+														+				22	"	
Aride			+												+							22	Unclassified	
Batken	+		+													+						22	"	
Chim			+													+						22	"	
Chobar Gorge				+												+						22	"	
Dhori			+												+	+		+				22	"	
Issyk-Kul				+			+						+		+	+				+		22	"	
Keterah				+									+		+							21	"	
Matucare				+														+				22	"	
Ngaingan						+										+						22	"	
Nyamanini				+																		21	"	
Slovakia				+											+			+				22	"	
Tettngang			+															+				22	"	
Wanowrie	+		+				+								+	+						22	"	

\* See footnote Table 5

\*\* Cuba



Table 31. Families Bunyaviridae, Herpesviridae, Reoviridae, Paramyxoviridae, Poxviridae, Rhabdoviridae, Togaviridae:  
Ungrouped Viruses - No Arthropod Vector Known

VIRUS	ISOLATED FROM												ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS			
	ARTHROPODS						VERTEBRATES						Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection		
	Mosq.	Ticks		Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats	Marsupials											Other	Sentinels
		Culicine	Anopheline																					
Bangui Bobaya							+			+					+	+				+		22 22	Bunyavirus-like "	
Agua Preta											+								+			22	Herpesvirus	
Ibaraki Ife											+		+			+						22 22	Orbivirus "	
Nariva									+										+			23	Paramyxovirus	
Salanga									+						+							22	Poxvirus	
Almpiwar												+					+					21	Rhabdoviridae	
Kern Canyon													+					+				23	"	
Keuraliba														+								22	"	
Klamath										+								+				22	"	
Lagos bat**														+								24	"	
Marco													+						+			22	"	
Mount Elgon bat																						23	"	
Navarro																			+			22	"	
Simian hem. fever								+									?			+		24	Togaviridae	

\* See footnote Table 5

\*\* Related to rabies virus and other lyssaviruses.

Table 32. Taxonomically Unclassified Viruses:  
Ungrouped Viruses - No Arthropod Vector Known

VIRUS	ISOLATED FROM													ISOLATED IN					HUMAN DISEASE		SEAS RATING*	TAXONOMIC STATUS				
	ARTHROPODS						VERTEBRATES							Africa	Asia	Australasia	Europe	North America	South America	Natural Infection			Lab Infection			
	Mosq.	Culicine	Anopheline	Ixodid	Argasid	Phlebotomine	Culicoides	Other	Man	Other Primates	Rodents	Birds	Bats											Marsupials	Other	Sentinels
Araguari														+											22	Unclassified
Belem																									22	
Bimbo																									22	
Gossas													+												23	
Hantaan										+															22	
Ippy											+														22	
Kammavanpettai													+												22	
Kannamangalam																									22	
Kolongo																									22	
Landjia																									22	
Le Dantec										+															22	
Ouango																									22	
Sakpa												+													22	
Sandjimba													+												22	
Sebokele														+											22	
Sembalam																									22	
Thottapalayam																									22	
Toure													+												22	
Yogue														+											22	

\* See footnote Table 5

Table 33. Continental Distribution of Grouped and Ungrouped Viruses.

Antigenic Group	Total in Group	Africa	Asia	Aus-tral-asia	Eur-ope	North Amer-ica	South Amer-ica	No. of Conti-nents involved					
								1	2	3	4	5	6
A	25	6	8	5	2	7	10	17	6	0	1	1	0
AHS	1	1	1	0	1	0	0	0	0	1	0	0	0
B	62	19	23	13	7	12	8	47	11	3	1	0	0
BAK	2	0	2	0	0	0	0	2	0	0	0	0	0
BLU	1	1	1	1	1	1	0	0	0	0	1	0	0
BTK	2	2	0	0	0	0	0	2	0	0	0	0	0
Bunyamwera Supergroup	ANA	4	0	0	0	0	1	4	0	0	0	0	0
	ANB	2	0	0	0	0	2	2	0	0	0	0	0
	BUN	18	4	1	0	2	8	16	2	0	0	0	0
	BWA	2	2	0	0	0	0	2	0	0	0	0	0
	C	11	0	0	0	0	5	9	2	0	0	0	0
	CAL	13	1	1	0	2	9	11	1	1	0	0	0
	CAP	8	0	0	0	0	3	7	6	2	0	0	0
	GAM	1	0	0	0	0	1	0	1	0	0	0	0
	GMA	10	0	0	0	0	2	9	1	0	0	0	0
	KOO	2	0	0	2	0	0	2	0	0	0	0	0
	MNT	1	0	0	0	0	1	0	1	0	0	0	0
	OLI	3	3	0	0	0	0	3	0	0	0	0	0
	PAT	4	0	0	0	0	4	4	0	0	0	0	0
	SIM	21	9	6	5	0	2	16	5	0	0	0	0
Naïro-viruses	TETE	5	4	1	0	2	0	3	2	0	0	0	0
	TUR	5	1	1	1	1	1	4	1	0	0	0	0
	SBU	1	0	1	0	0	0	1	0	0	0	0	0
	CGL	7	0	0	0	0	1	6	7	0	0	0	0
	CTF	2		0	0	1	1	0	2	0	0	0	0
	COR	2	1	0	1	0	0	0	2	0	0	0	0
	EHD	1	1	0	0	0	1	0	0	1	0	0	0
	EUB	3	1	0	2	0	0	3	0	0	0	0	0
	HP	3	0	0	0	0	2	1	3	0	0	0	0
	KSO	3	0	2	0	0	1	0	3	0	0	0	0
	KEM	16	3	4	1	4	6	14	1	1	0	0	0
	KWA	1	0	0	0	0	0	1	0	0	0	0	0
	MAL	2	1	1	0	0	0	2	0	0	0	0	0
	MAP	4	0	0	4	0	0	4	0	0	0	0	0
Ungrouped	MBG	2	2	0	0	1	0	1	1	0	0	0	0
	MTY	3	3	0	0	0	0	3	0	0	0	0	0
	MOS	2	2	0	0	0	0	2	0	0	0	0	0
	CHF-CON	3	2	3	0	2	0	1	0	2	0	0	0
	DGK	5	2	4	1	0	0	3	2	0	0	0	0
	HUG	4	1	1	0	1	3	2	1	1	0	0	0
	NSD	3	2	1	0	0	0	3	0	0	0	0	0
	QYB	2	2	0	0	0	0	2	0	0	0	0	0
	SAK	5	0	2	1	1	2	4	1	0	0	0	0
	NDO	1	1	0	0	0	0	1	0	0	0	0	0
	PAL	4	0	3	1	0	0	4	0	0	0	0	0
	PHL	30	6	5	0	3	10	26	2	2	0	0	0
	QRF	2	1	0	1	0	0	2	0	0	0	0	0
	SAW	3	0	0	0	0	3	0	3	0	0	0	0
	TCR	9	1	0	0	0	1	7	9	0	0	0	0
	THO	1	1	0	0	1	0	0	1	0	0	0	0
	TIM	2	0	0	0	0	0	2	0	0	0	0	0
	TR	2	0	2	0	0	0	2	0	0	0	0	0
	UPO	2	0	0	1	0	1	2	0	0	0	0	0
	UUK	5	0	2	0	3	0	5	0	0	0	0	0
	VSV	8	1	2	0	0	2	6	5	3	0	0	0
	WAL	1	0	0	1	0	0	1	0	0	0	0	0
	WAR	2	0	0	2	0	0	2	0	0	0	0	0
Totals	446	125	101	57	40	101	114	379	48	15	2	2	0

Table 34. Number of Viruses Isolated From Wild Caught Arthropods

Antigenic Group	Isolated From						No. of Class- es. Involved		
	Total in Group	Mosq.	Ticks	Phlebot- mine Flies	Culi- coides	Other	1	2	3
A	25	24	1	0	1	5	21	2	2
AHS	1	0	0	0	1	0	1	0	0
B	62	29	17	0	0	2	40	4	0
BAK	2	2	1	0	0	0	1	1	0
BLU	1	0	0	0	1	0	1	0	0
BTK	2	1	0	0	0	0	1	0	0
Bunyamwera Supergroup	ANA	4	4	0	0	0	4	0	0
	ANB	2	2	0	0	0	2	0	0
	BUN	18	17	0	0	2	17	1	0
	BWA	2	2	0	0	0	2	0	0
	C	11	11	0	0	0	11	0	0
	CAL	13	13	0	0	1	12	1	0
	CAP	8	7	0	0	0	7	0	0
	GAM	1	1	0	0	0	1	0	0
	GMA	10	8	0	1	0	7	1	0
	KOO	2	2	0	0	0	2	0	0
	MNT	1	0	0	0	0	0	0	0
	OLI	3	3	0	0	0	3	0	0
	PAT	4	3	0	0	0	3	0	0
	SIM	21	10	0	0	11	11	5	0
	TETE	5	0	2	0	0	2	0	0
	TUR	5	5	0	0	0	5	0	0
	SBU	1	0	0	0	0	1	0	0
CGL	7	0	0	6	0	0	6	0	0
CTF	2	0	2	0	0	0	2	0	0
COR	2	2	0	0	0	0	2	0	0
EHD	1	0	0	0	0	0	0	0	0
EUB	3	3	0	0	0	0	3	0	0
HP	3	3	0	0	0	0	3	0	0
KSO	3	0	3	0	0	0	3	0	0
KEM	16	0	16	0	0	0	16	0	0
KWA	1	1	0	0	0	0	1	0	0
MAL	2	2	0	0	0	0	2	0	0
MAP	4	4	0	0	0	0	4	0	0
MBG	2	0	0	0	0	0	0	0	0
MOS	2	2	0	0	0	0	2	0	0
MTY	3	0	0	0	0	0	0	0	0
Nairo- viruses	CHF-CON	3	0	3	0	1	2	1	0
	DGK	5	0	5	0	0	5	0	0
	HUG	4	0	4	0	0	4	0	0
	NSD	3	2	3	0	1	1	1	1
	QYB	2	0	2	0	0	2	0	0
	SAK	5	0	5	0	0	5	0	0
NDO	1	1	0	0	0	0	1	0	0
PAL	4	3	0	0	1	0	4	0	0
PHL	30	5	0	18	0	0	19	1	1
QRF	2	0	2	0	0	0	2	0	0
SAW	3	0	3	0	0	0	3	0	0
TCR	9	1	1	0	0	3	3	1	0
THO	1	0	1	0	0	0	1	0	0
TIM	2	0	0	0	0	0	0	0	0
TR	2	0	0	0	0	0	0	0	0
UPO	2	0	2	0	0	0	2	0	0
UUK	5	0	5	0	0	0	5	0	0
VSV	8	3	0	3	0	2	4	2	0
WAL	1	0	0	0	1	0	1	0	0
WAR	2	0	0	0	2	0	2	0	0
Ungrouped	97	40	20	3	2	1	58	4	0
Totals	446	216	98	31	24	15	323	25	4

Table 35. Number of Viruses Isolated From Naturally Infected Vertebrates

Anti- genic- Group	Total in Group	Man	Other Pri- mates	Rod- ents	Birds	Bats	Marsu- pials	Live- stock	All others	No. of Classes Involved						
										1	2	3	4	5	6	
A	25	11	2	6	11	3	6	6	3	7	5	2	3	1	1	
AHS	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	
B	62	28	4	19	15	13	1	5	6	28	8	5	4	2	1	
BAK	2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	
BLU	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	
BTK	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	
Bunyamwera Supergroup	ANA	4	1	1	0	0	0	0	0	0	1	0	0	0	0	
	ANB	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
	BUN	18	4	1	3	0	0	1	3	8	2	0	0	0	0	
	BWA	2	1	0	0	0	0	0	0	1	0	0	0	0	0	
	C	11	10	0	8	0	1	5	0	1	2	5	3	1	0	0
	CAL	13	3	0	4	0	0	0	0	1	4	2	0	0	0	0
	CAP	8	0	0	4	0	0	1	0	0	3	1	0	0	0	0
	GAM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GMA	10	2	0	7	2	2	4	0	0	4	1	1	2	0	0
	KOO	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MNT	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OLI	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PAT	4	0	0	3	0	0	0	0	0	3	0	0	0	0	0
	SIM	21	2	1	0	4	0	0	8	4	12	3	0	0	0	0
TETE	5	0	0	0	5	0	0	0	0	5	0	0	0	0	0	
TUR	5	0	0	0	2	0	0	0	1	1	1	0	0	0	0	
SBU	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	
CGL	7	1	0	1	0	0	0	0	0	2	0	0	0	0	0	
CTF	2	1	0	1	0	0	0	0	1	0	0	1	0	0	0	
COR	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	
EHD	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	
EUB	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
HP	3	0	0	0	2	0	0	0	0	2	0	0	0	0	0	
KSO	3	0	1	0	1	0	0	0	1	3	0	0	0	0	0	
KEM	16	1	0	1	1	0	0	1	0	0	2	0	0	0	0	
KWA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
MAL	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
MAP	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
MBG	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0	
MOS	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	
MTY	3	0	0	0	3	0	0	0	0	3	0	0	0	0	0	
Nairo- viruses	CHF-CON	3	2	0	0	0	0	1	1	1	1	0	0	0	0	
	DGK	5	0	0	0	0	0	0	0	0	0	0	0	0	0	
	HUG	4	0	0	0	1	0	0	0	1	0	0	0	0	0	
	NSD	3	3	0	1	0	0	0	2	1	1	1	1	0	0	0
	QYB	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	SAK	5	0	0	0	1	0	0	0	0	1	0	0	0	0	0
NDO	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	
PAL	4	0	0	0	0	0	0	1	0	1	0	0	0	0	0	
PHL	30	7	0	8	2	0	2	1	2	14	4	0	0	0	0	
QRF	2	1	0	0	1	0	0	0	0	0	1	0	0	0	0	
SAW	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TCR	9	3	0	8	0	1	0	0	1	6	2	1	0	0	0	
THO	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	
TIM	2	0	0	0	0	0	0	0	2	2	0	0	0	0	0	
TR	2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	
UPO	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
UUK	5	0	0	1	1	0	0	0	0	0	1	0	0	0	0	
VSV	8	4	0	1	0	0	1	3	2	1	5	0	0	0	0	
WAL	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WAR	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ungrouped	97	9	1	13	15	11	1	4	4	51	2	1	0	0	0	
Totals	446	98	13	90	70	32	21	36	35	180	49	15	10	3	2	

Table 36. Number of Viruses Associated with Naturally or Laboratory Acquired Disease in Man

Antigenic Group	Total in Group	In Nature	Lab. Infection	Either or Both	
				Number	Percent
Group A	25	11	8	12	48.0
Afr. horsesickness	1	0	0	0	
Group B	62	28	25	31	50.0
Bakau	2	0	0	0	
Bluetongue	1	0	0	0	
Boteke	2	0	0	0	
Bunyamwera Supergroup	Anopheles A	4	1	0	25.0
	Anopheles B	2	0	0	
	Bunyamwera	18	5	2	33.3
	Bwamba	2	1	0	50.0
	C	11	10	2	90.9
	California	13	5	0	38.5
	Capim	8	0	0	
	Gamboia	1	0	0	
	Guama	10	2	0	20.0
	Koongol	2	0	0	
	Minatitlan	1	0	0	
	Olifantsevlei	3	0	0	
	Patios	4	0	0	
	Simbu	21	2	1	9.5
	Tete	5	0	0	
	Turlock	5	0	0	
	SBU	1	0	0	
Changuionola	7	1	0	1	14.3
Colorado tick fever	2	1	1	1	50.0
Corriparta	2	0	0	0	
Epizoot. hem. dis.	1	0	0	0	
Eubenangee	3	0	0	0	
Hart Park	3	0	0	0	
Kaisodi	3	0	0	0	
Kemerovo	16	1	1	1	6.3
Kwatta	1	0	0	0	
Malakal	2	0	0	0	
Mapputta	4	0	0	0	
Marburg	2	2	2	2	100.0
Matariya	3	0	0	0	
Mossuril	2	0	0	0	
Nairo-viruses	CHF-Congo	3	1	1	33.3
	Dera Ghazi Khan	5	0	0	
	Hughes	4	0	0	
	Nairobi sheep dis.	3	3	2	100.00
	Qalyub	2	0	0	
	Sakhalin	5	0	0	
Nyando	1	1	0	1	100.00
Palyam	4	0	0	0	
Phlebotomus fever	30	6	1	6	20.0
Quaranfil	2	1	0	1	50.0
Sawgrass	3	0	0	0	
Tacaribe	9	3	5	5	55.6
Tanjong Rokok	2	0	0	0	
Thogoto	1	1	0	1	100.0
Timbo	2	0	0	0	
Upolu	2	0	0	0	
Uukuniemi	5	0	0	0	
Vesicular stom.	8	4	3	5	62.5
Wallal	1	0	0	0	
Warrego	2	0	0	0	
Ungrouped	97	7	1	8	8.2
Totals	446	97	55	106	23.8

Table 37. Evaluation of Arthropod-Borne Status of 446 Registered Viruses (SEAS)

Anti- genic Group	Total in Group	Arbo- virus	Prob- ably Arbo- virus	Pos- sible Arbo- virus	Prob- ably not Arbo- virus	Not Arbo- virus	Arbo or Probably Arbo		Not or Probably Not Arbo	
							No.	%	No.	%
A	25	16	5	4	0	0	21	84.0	0	
AHS	1	1	0	0	0	0	1	100.0	0	
B	62	30	8	17	2	5	38	61.2	7	11.3
BAK	2	0	1	1	0	0	1	50.0	0	
BLU	1	1	0	0	0	0	1	100.0	0	
BTK	2	0	0	2	0	0	0		0	
Bunyamwera Supergroup	ANA	4	0	2	2	0	2	50.0	0	
	ANB	2	0	0	2	0	0		0	
	BUN	18	8	5	5	0	13	72.2	0	
	BWA	2	1	1	0	0	2	100.0	0	
	C	11	10	1	0	0	11	100.0	0	
	CAL	13	10	1	2	0	11	84.6	0	
	CAP	8	4	2	2	0	6	75.0	0	
	GAM	1	0	0	1	0	0		0	
	GMA	10	5	3	2	0	8	80.0	0	
	KOO	2	0	2	0	0	2	100.0	0	
	MNT	1	0	0	1	0	0		0	
	OLI	3	0	0	3	0	0		0	
	PAT	4	1	1	2	0	2	50.0	0	
	SIM	21	3	5	13	0	8	38.1	0	
	TETE	5	0	1	4	0	1	20.0	0	
TUR	5	1	2	2	0	3	60.0	0		
SBU	1	0	0	1	0	0		0		
CGL	7	0	1	6	0	0	1	14.3	0	
CTF	2	1	0	1	0	0	1	50.0	0	
COR	2	0	1	1	0	0	1	50.0	0	
EHD	1	0	1	0	0	0	1	100.0	0	
EUB	3	0	0	3	0	0	0		0	
HP	3	0	1	2	0	0	1	33.3	0	
KSO	3	0	1	2	0	0	1	33.3	0	
KEM	16	0	3	13	0	0	3	18.8	0	
KWA	1	0	0	1	0	0	0		0	
MAL	2	0	0	2	0	0	0		0	
MAP	4	0	1	3	0	0	1	25.0	0	
MBG	2	0	0	0	2	0	0		2	100.0
MOS	2	0	0	2	0	0	0		0	
MTY	3	0	0	3	0	0	0		0	
Nairo- viruses	CHF-CON	3	2	0	1	0	2	66.7	0	
	DGK	5	0	0	5	0	0		0	
	HUG	4	1	1	2	0	2	50.0	0	
	NSD	3	1	0	2	0	1	33.3	0	
	QYB	2	0	0	2	0	0		0	
	SAK	5	0	1	4	0	1	20.0	0	
NDO	1	0	1	0	0	0	1	100.0	0	
PAL	4	0	0	4	0	0	0		0	
PHI	30	4	9	17	0	0	13	43.3	0	
QRF	2	2	0	0	0	0	2	100.0	0	
SAW	3	0	0	3	0	0	0		0	
TCR	9	0	0	0	0	9	0		9	100.0
THO	1	0	0	1	0	0	0		0	
TIM	2	0	0	2	0	0	0		0	
TR	2	0	0	2	0	0	0		0	
UPO	2	0	0	2	0	0	0		0	
UUK	5	1	1	3	0	0	2	40.0	0	
VSV	8	3	0	5	0	0	3	37.5	0	
WAL	1	0	0	1	0	0	0		0	
WAR	2	0	0	2	0	0	0		0	
Ungrouped	97	3	11	75	5	3	14	14.4	8	8.2
Totals	446	109	73	238	9	17	182	40.8	26	5.8

REPORT FROM THE MRC VIRUS RESEARCH UNIT, UNIVERSITY OF OTAGO,  
DUNEDIN, NEW ZEALAND.

*Transmission of Ross River Virus in the laboratory:*

Because of the risk that Ross River Virus (RRV) which had caused large outbreaks of polyarthrititis and rash in the Pacific islands during 1979-1980 could be introduced into New Zealand by a viraemic traveller, studies were made of the competence of some local mosquito species to transmit RRV after intrathoracic injection of the virus or after feeding on viraemic suckling mice.

*Aedes notoscriptus*, which is particularly numerous around the large city of Auckland, failed to transmit the virus after feeding on virus intake levels ranging from 1.5 to 6.7 TCID<sub>50</sub>. Attempts to transmit were made with 349 engorged females from Day 8 to Day 26 after feeding, but no transmission occurred.

In contrast, the mosquito *Aedes australis* which has a major distribution covering the southern part of New Zealand and the eastern coast of Australia together with Norfolk Island, proved to be a very efficient vector after both injection and feeding. In six experiments using 626 mosquitoes, transmission was found to occur readily following i.t. doses as low as 3.5 TCID<sub>50</sub> or after feeding intakes as low as 3.0 TCID<sub>50</sub>. Successful attempts were made to transmit virus to uninfected suckling mice from the 16th Day to the 28th Day following i.t. injection and Day 13 to Day 27 following feeding. Attempts were not made at earlier times.

In one experiment with *Aedes australis* 120 females were injected with approximately 3.3 TCID<sub>50</sub> by the i.t. route, held at room temperature for 27 days then fed on 26 uninfected newborn mice. 22 of these became viraemic and were exposed to a cage containing uninfected *A. australis*. All mosquitoes which were found to have engorged were removed, held at room temperature (15-18°C) and then allowed to feed on more uninfected newborn mice 14 days later, thus completing a full cycle of natural transmission. 70% of the mice exposed to these mosquitoes were positive for RRV at post-mortem, this being determined by FA staining of brain. Virus was isolated and identified by neutralisation test. All mosquitoes used in these experiments were laboratory-reared from larvae and pupae collected from pools where no alphavirus is known to exist.

(T. Maguire and F.J. Austin)



REPORT FROM THE ARBOVIRUS LABORATORY  
INSTITUT PASTEUR DE NOUMEA - NEW CALEDONIA

ISOLATION AND TYPING OF DENGUE TYPE 4 VIRUS  
BY USING TWO DIFFERENT METHODS

During an outbreak of a dengue-like disease, in New Caledonia, 224 clinical cases were investigated in order to isolate and to identify the causative agent.

Sera obtained from the patients in acute phase were inoculated intra-cerebrally (0.02 ml) to suckling mice litters 1-2 days old, yielding 49 viral strains (21.9 per 100). Pathogenic effect was paralysis and death 12-14 days after primary inoculation, in 38 cases, or after a blind passage in 11 cases ; minimum survival time was 5 days after 3-5 passages.

Complement fixation and/or haemagglutination inhibition tests performed on purified antigens prepared from 43 strains, using anti-dengue 1, 2, 3 and 4 specific mouse ascitic fluids (National Institutes of Allergy and Infectious Diseases), showed closest antigenic relationship to type 4 virus.

Diluted sera (1:5) from 94 patients were also inoculated (0,3 microliter) to *Toxorhynchites amboinensis* adult mosquitoes, colonized in the laboratory, using the intra-thoracic route. Viral infection was demonstrated after 14 days incubation at 28-30°C, by indirect immunofluorescent staining (IIF) on head squashes. At the same time, other batches of *Toxorhynchites* were infected by the prototype strains of dengue and Ross River viruses to perform the titration of specific antibodies on head squashes, using the same mouse ascitic fluids from N.I.A.I.D. Homologous titers were found always more than 1/100, as shown in the following table :

		Anti-dengue antibodies					anti RR
Type :		1	2	3	4		antibodies
Dil. :		100	100	100	100	200	100
Antigen	DEN 1	+++	N	N	+	N	N
	DEN 2	N	+++	N	N	N	N
	DEN 3	N	N	+++	N	N	N
	DEN 4	+	N	N	+++	+++	N
	R R	N	N	N	N	N	+++

Intra-thoracic inoculation to *Toxorhynchites* (IT) revealed an infection by dengue type 4 virus, in 52/94 cases (53 per 100).

Comparison of the two methods was possible in 80 cases; concurrent inoculation of patients sera to suckling mice (ICS) and to *Toxorhynchites* (IT) gave the following results.

	ICS positive	ICS negative	Total
IT positive .....	19	19	38
IT negative .....	3	39	42
Total .....	22	58	80

Sero-diagnosis were performed in 186 cases, when paired sera were available. On 43 patients found infected by dengue 4 virus, 16 showed a primary immune response and 27 a secondary response. On 143 cases where no virus isolation was obtained, 83 patients (58 p.100) showed a primary response and 42 (29.4 p.100) a secondary response.

Anti-Flavivirus antibodies were titrated in the sera from which strains were obtained, with the following results.

Anti-dengue a.b. titer (reciprocal)	10	10	20	40	80	160	640	1280
Number of virus isolation	10	9	9	6	4	3	1	1

These investigations showed that the use of *Toxorhynchites* to demonstrate infections by dengue 4 virus is a more sensitive method than the usual inoculation to baby mice. Typing on mosquitoes head squashes, using IIF staining, is also possible and leads to the same results as CF and HI tests using mouse brain antigens.

P. FAURAN

G. LE GONIDEC

DHF in Thai Infants: Evidence for immune enhancement of dengue virus  
growth by transplacentally acquired antibody

Previous studies in Bangkok have shown that the age distribution of dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) is bi-phasic with one peak of cases at 6-9 months and second larger peak at 4-5 years. Every year the virus type most commonly isolated from both age groups of patients with DHF/DSS is D2. Serologic data has shown that infant (0-12 months) DHF/DSS is always due to a primary flavivirus infection while childhood (1-15 years) DHF/DSS is usually due to a secondary infection. When cases from 1979 and 1980 were analyzed by the serotype of the infecting virus, severe D2 infections were found to occur exclusively in children with pre-existing flavivirus immunity, while severe D1 infections (although unusual) occurred in either immunes or non-immunes.

Dependence on pre-existing dengue antibody for development of the severe form of dengue virus infection in vivo may relate in the in vitro phenomenon of antibody dependent enhancement (ADE) of D2 virus growth in mononuclear phagocytes. We studied infants with DHF and their mothers to determine the role of passively transferred maternal antibody in the development of DHF/DSS in infants. Acute and convalescent sera of infants with DHF/DSS due to D2 infection (proven serologically and by virus isolation) were collected from Bangkok Children Hospital during 1979-1980. Acute and convalescent sera of mothers of these DHF infants were also collected at the same time. For controls, sera from mothers of infants with febrile illnesses other than dengue fever and from mothers of DHF/DSS toddlers (1-3 yrs) were collected. Mothers' acute sera from the three study groups were tested for their neutralizing activity against D2 virus by the PRNT50 method. All mothers' sera had detectable D2 PRNT50 antibodies. The average PRNT50 titers for the mothers of DHF infants, non-DHF infants and DHF toddlers were not statistically different ( $\log_{10}$  2.5,  $\log_{10}$  2.3, and  $\log_{10}$  2.8 respectively). The titer of D2 neutralizing antibody detected in a mother's serum at the time of her infant's illness was assumed to be stable and to be similar to the titer when the child was born, and hence also a direct reflection of the infant's antibody titer (transplacentally acquired) at the time of birth. We calculated the time required for dengue antibody to decay below protective levels ( $< 1:10$ ) for each infant, taking the half-life of human IgG to be thirty days. We found a strong correlation between the D2 PRNT50 titer of infant DHF mothers' sera and the age of their infant at the onset of DHF ( $p=.0003$ ). No such correlation of maternal antibody titer and child age was found among mother and infant pairs in the control groups. Furthermore, the age of which DHF occurred in infants was characteristically 2-3 months (2-3 IgG half-lives) beyond the age at which protective passive antibody was calculated to have fallen below protective levels (See Table I). We then tested mothers' sera (blind coded) from the

3 study groups for ADE of D2 growth in the mouse macrophage-like line P-388. All mothers' sera were shown to enhance growth of prototype D2 virus (by factors of 1.6 to 15 times) with peak enhancing activity at dilutions approximately 10 fold beyond the neutralizing end point.

We interpret these findings to suggest that maternal antibody in infants is protective early in life until the time of disappearance of maternal neutralizing titer; after this enhancing activity alone is expressed for 2 or 3 months. If a particular infant is infected with D2 during this interval (the DHF "at risk window"), DHF or DSS may result (Figure 1).

Srisakul Kliks, Donald Burke, Ananda Nisalak, and Suchitra Nimmanitya

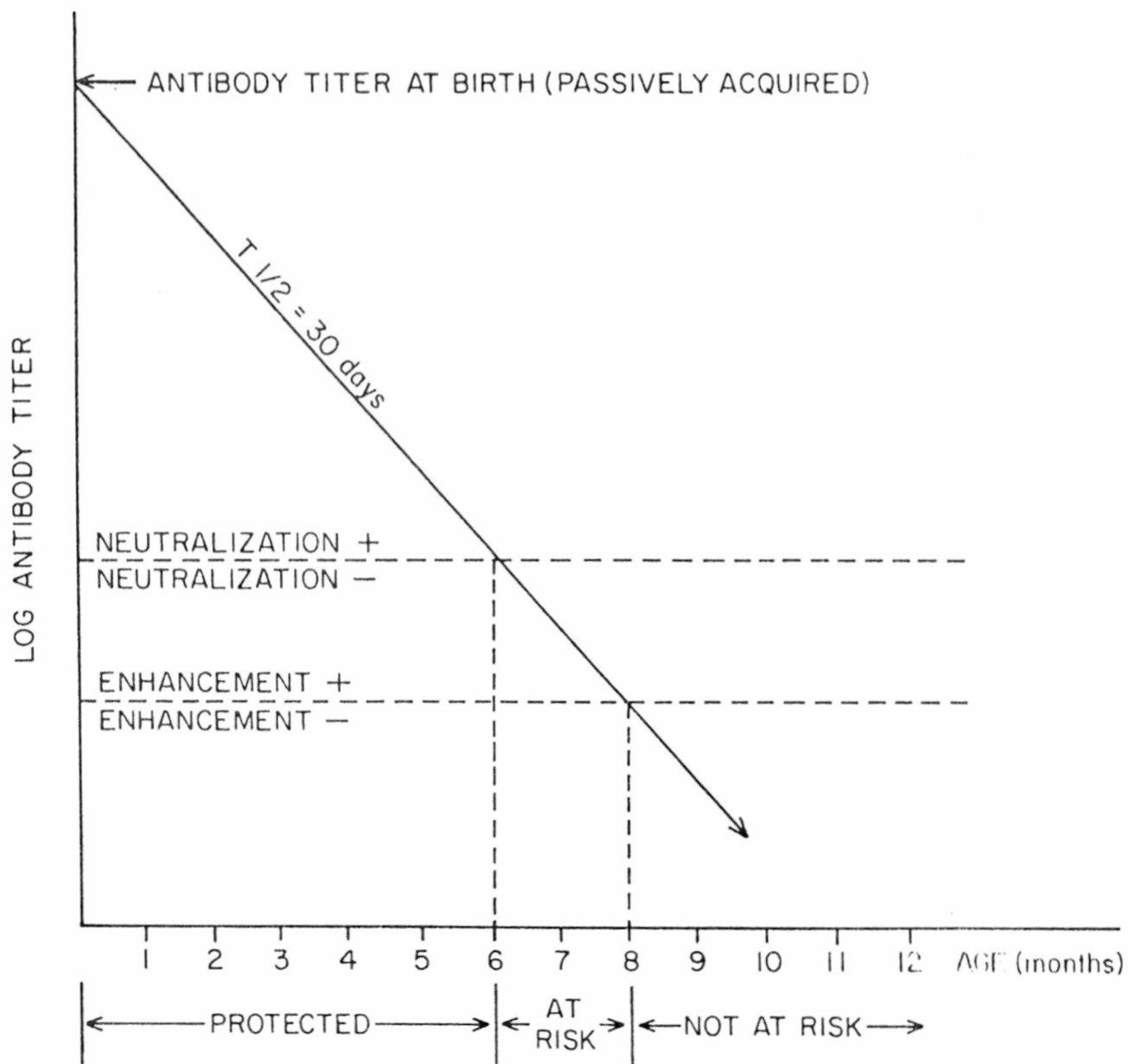


FIGURE I.

TABLE I,  
CORRELATION OF INFANT AGE AT ONSET OF DHF WITH MOTHER'S  
DEN-2 PRNT<sub>50</sub> TITER

GROUP I CASE #	MOTHERS DEN-2 PRNT <sub>50</sub>	CALCULATED* TIME FOR INFANT ANTIBODY TO FALL TO <1:10 (MONTHS)	INFANT AGE AT ONSET OF DHF (MONTHS)	AGE ONSET DHF - AGE ANTIBODY DISAPPEARANCE (MONTHS)
1	30	2	4	2
2	50	3	3	0
3	80	4	6	2
4	90	4	8	4
5	200	5	7	2
6	290	5	7	2
7	350	6	8	2
8	360	6	4	-2
9	420	6	8	2
10	500	6	6	0
11	720	7	8	1
12	2000	8	11	3
13	8200	10	12	2

\* ASSUMES T  $\frac{1}{2}$  PASSIVE ANTIBODY = 30 DAYS.

REPORT FROM WHO COLLABORATING CENTER FOR ARBOVIRUS  
REFERENCE AND RESEARCH, INSTITUTE OF VIROLOGY,  
817 03 BRATISLAVA, CZECHOSLOVAKIA

The observations on man-biting activity of the most abundant mosquito species in different collecting sites were carried out at Jurský Šúr Nature Reserve which lies on the southern foot of the Little Carpathians Mountains about 6 km northeast of Bratislava.

Our sampling sites were located on the western edge of the alder-wood, where three different but closely situated sites were chosen. One sampling site in the open was on the meadow where grass was cut short, the second sampling site was in the edge of the wood just under the end of the branches where in the afternoon the site was exposed to the full sun and the third site was in the alder-wood situated in the thick growth of the nettle (*Urtica dioica* L.), which was not exposed to full sun at any time of the day. Three observers (A,B,C) collected attacking mosquitoes for one day from dawn to dusk on May 31, June 29, July 26, August 28 and September 26, 1979 for a period of ten minutes every two hours in each of the three sites starting with the meadow, moved to the edge and then to the wood. Battery or mouth operated aspirators were used to collect mosquitoes that landed on the observers body. There was no rotation of observers between sampling sites or lines. Supplemented CO<sub>2</sub> was released from about 1/2 kg of dry ice at the feet of observers A and C.

In total, 10 681 Ae. cantans mosquitoes were collected, which represents 47.0 % out of 22 702 mosquitoes belonging to 20 species obtained in 1979.

The highest biting activity of Ae. cantans was always registered in the wood and it was relatively high in any time of the day. The biting activity usually clearly declined in the evening.

In the edge of the wood the activity of Ae. cantans mosquitoes was also high and the changes in it were minimal, especially in May and with application of supplemented CO<sub>2</sub>. Two peaks were registered with CO<sub>2</sub> in June and July - in the morning at 7 hr (with one exception) and in the evening at 21 hr. When supplemented CO<sub>2</sub> was not used, the difference in the occurrence of morning and evening peaks was found out only in July, when evening activity reached the peak earlier, at 19 hr.

No biting activity of mosquitoes was registered at all during 18 hrs catching period in the meadow in May.

The biting activity was here strictly limited to the early morning and late evening hours in June. In July, the activity was limited again to the morning and evening hours with the peaks at 7 and 21 hrs, but the morning peak was high. In August, only 7 Ae. cantans females were collected in the meadow.

In total, 7 245 Ae. vexans mosquitoes were collected (31.9 % of all mosquitoes collected).

The highest biting activity of Ae. vexans was also found out in the alder-wood, but the activity was not so uniform as the activity of Ae. cantans. When CO<sub>2</sub> was used, the morning peak of activity was not observed.

In the edge of the wood the abundance of Ae. vexans was highest in May, when with supplemented CO<sub>2</sub> the smallest differences in the biting activity were observed. Lowest activity was in June at 19 hr and in July at 17 hr.

The activity of Ae. vexans in the meadow, was limited to the morning and to the evening hours. It was limited very strictly in June and August, but in July its persistence lasted in low level till the noon with the peaks at 5 or 7 and 21 hrs.

Totally, 2 664 Ae. cinereus mosquitoes were collected at bite (11.7 % of all mosquitoes collected).

When comparing the tree collecting sites, the attack rate of Ae. cinereus was the smallest in the wood. The activity of Ae. cinereus in the wood was relatively higher in the morning (from 5 till 9 hrs), then in the evening (17-19 hrs).

In the wood-edge the morning activity was in some cases also high, other times there were the sharp evening peaks at 21 hr or at 19 hr, respectively. Very low or interrupted activity was at 15 hr in June and July. It is of interest, that the peaks of activity of Ae. cantans and Ae. vexans mosquitoes in the edge were at 15 hr at site B in July.

In the meadow, where the abundance of attacking Ae. cinereus mosquitoes was highest, its activity was limited again to the morning and to the evening hours mainly in June and prolonged its activity till noon in July.

(M. Labuda, M. Kozánek, M. Slovák)



THE USE OF RADIAL HEMOLYSIS IN GEL FOR SERODIAGNOSIS OF  
TICK-BORNE ENCEPHALITIS

The test of radial hemolysis in gel (RHG) modified for arboviruses by S.Ya.Gaidamovich and E.E.Melnikova (1) had been previously used for serodiagnosis of dengue fever and Venezuelan equine encephalomyelitis (2,3). In the epidemic season of 1980 this test was used for serodiagnosis of tick-borne encephalitis. Altogether, 464 serum specimens from 258 patients diagnosed as having tick-borne encephalitis and subjects suspect for this disease were examined. The diagnosis of tick-borne encephalitis was confirmed in 77 cases and rejected in 181, the results of RHG and hemagglutination-inhibition (HI) tests coinciding completely.

A comparative analysis of the antibody levels by the results of RHG and HI tests showed clear-cut correlation. At antihemagglutinin titres of 1:80 or more RHG is also always positive, but at lower antihemagglutinin titres the results of HI and RHG tests do not always coincide. As a rule, most frequently the results of RHG and HI differ for the sera collected early in the disease and showing HI titres of 1:20 to 1:40. This is probably due to the prevalence in them of IgM antibody which are undetectable by RHG. With an increase of IgG antibody RHG becomes positive. Thus, the diagnostic value of RHG is not inferior to that of HI and even permits a more accurate demonstration of seroconversion.

Antibody detection rate by RHG in relation to antihemagglutinin  
titres

Antihemagglutinin titres	1:10	1:20	1:40	1:80	1:160	1:320 and more	
No. of sera positive by RHG in relation to that positive by HI	In absolute numbers	2/19 <sup>x)</sup>	7/13	12/22	31/37	30/33	46/46
	In %	10.5	53.8	54.5	83.7	90.9	100

x) Numerator - no. of sera positive by RHG, denominator -no.of sera positive by HI test.

A most advantageous feature of RHG is its insensitivity to serum inhibitors which, at low antihemagglutinin titres (1:10, 1:20), allows the distinction between true antibody and inhibitors to be made.

1. Gaidamovich, S. Ya., Melnikova, E. E. - Passive hemolysis-in-gel with Togaviridae arboviruses. Intervirology, 1980, v.13, p.16-20.
2. Gaidamovich, S. Ya., Melnikova, E. E., Siddiki, S. M. - Radial hemolysis in gel for serodiagnosis of dengue fever (in Russian). Vopr.virusol 1980, No, 3, p.375-377.
3. Gaidamovich, S. Ya., Melnikova, E. E., Obukhova, V. R. - Radial hemolysis in gel used in serological studies on Venezuelan equine encephalomyelitis virus. Acta virol., 1980, v.25, p.36-40.

(S. Ya. Gaidamovich, E. E. Melnikova)

Comparison of hemagglutination patterns of Bluetongue virus

In an earlier publication we reported upon the hemagglutination of Bluetonguevirus,\* and indicated that different isolates of one serotype had distinct hemagglutination patterns. We have now tested some 20 different isolates or egg passaged Bluetongue virus samples belonging either to the serotype 3 or 10. Though low titer hemagglutination may be obtained with concentrated supernatant virus, all the virus preparations tested were obtained from cell extracted material. In this way a 10-50 fold higher HA-titer was usually obtained. Sheep, Guinea pig and human red blood cells (0, rh+) were tested. All erythrocyte preparations were adjusted to 1%. The HA tests performed resulted in 3 different patterns which we designated group I to group III. Group I hemagglutination pattern was allocated to isolates which hemagglutinated sheep red blood cells to a high titer with minimal hemagglutination of guinea pig red blood cells and no hemagglutination of human red blood cells. Group II HA-pattern isolates hemagglutinated all three erythrocyte species to about the same titer and group III isolates hemagglutinated human and guinea pig erythrocytes to a considerably higher titer ( $3-5 \log_2$ ) than sheep red blood cells. Designation of the various isolates to the above grouping showed that vaccine strains BT8 (type 10) and 535 45E 3P (type 3) belong to group I (the latter being the type 3 vaccine strain in South Africa). Typical representatives of group II are the virus isolates 70/76 and 11/76 (field isolates from South Africa) as well as 8231 (being a low egg passage material from type 3). The reference virulent strains from type 3 and type 10 are members of group III. In all cases the HA specificity was verified with HA tests performed with reference sheep or guinea pig sera.

In addition, hemagglutination inhibition titers with the different erythrocytes using the same serum and antigen, i.e. type 10 virulent strain, differed considerably. Whereas HI titers obtained with sheep erythrocytes coincided approximately with the serum neutralisation titers, HI titers with guinea pig and human erythrocytes were up to  $5 \log_2$  higher. This lends support to the speculation that two different hemagglutinins are present on virulent strains. As HI titers for guinea pig and human erythrocyte systems are consistently higher it would appear that hemagglutinins for these two erythrocytes are closely located to the sheep erythrocyte hemagglutinin. Higher HI titers could be explained by a steric configuration whereby antibodies inhibiting the sheep erythrocytes hemagglutinin simultaneously inhibit several hemagglutinins of guinea pig and human red blood cells.

The marked differences observed in the hemagglutination must be considered as an additional way of determining the relationship between orbiviruses and their potential to cause disease. It would therefore appear that hemagglutination patterns as indicated help to classify Bluetongue virus isolates with regard to pathogenicity and virulence.

\* All Bluetongue virus isolates indicated except BT8 were kindly supplied by Dr. B.J. Erasmus, V.R.I. Onderstepoort, RSA

Further studies on the ecology and epidemiology of the Phlebotomus-transmitted Toscana virus

In the summer 1971, during field studies on the ecology of arboviruses in Italy, three strains of a new virus were isolated from sandflies, mostly females, of a pure colony of Phlebotomus perniciosus collected in a central Italian region (Toscana, Grosseto province). The prototype strain (ISS.Phl.3) was named Toscana virus, assigned to the Phlebotomus fever group and registered in 1980 in the International Catalogue of Arboviruses.

Antibodies to Toscana virus were detected by PRNT in human sera. Serological surveys carried out to estimate the natural distribution of Toscana virus in Italy showed that antibodies to this virus can be detected in humans mainly of Toscana region: a high infection rate (24.8%) was observed among human residents of the province of Florence, antibodies being present in all age groups.

In view of these results showing a high rate of human infection and of the data of CNS pathogenicity in laboratory animals including monkeys (Macaca fascicularis), we attempted to investigate a possible role of Toscana virus as a causative agent of human disease. In particular we attempted to find an association of Toscana virus with acute CNS disease.

During the period between 1977 to 1980, 132 patients affected by acute CNS disease were investigated serologically for arbovirus infections. Most of these patients were admitted to the Infectious Diseases Department of the General Hospital (S.Maria Nuova) and to the Department of Neurology of the University in Florence, with a few from neighbouring hospitals. Sixteen individuals (12.1%) were found to have had a recent infection with Toscana virus by the HI, CF and/or PRN tests (Table 1). They showed evidence of seroconversions by one or more of these three serological techniques. A few acute serum samples were tested and found positive for the presence of specific IgM by indirect fluorescent antibody technique. As shown in Table 1, all Toscana virus reactors occurred during summer (from June to October), thus confirming the possibility of presumptive vector-borne disease. All patients were adults; 11 were males and 5 females. In the 16 cases no fatalities nor severe sequelae were recorded.

Although these data could suggest a presumptive association of Toscana virus with acute CNS disease, we cannot consider it definitely

since we do not know yet the number of seroconversions occurring during summer in the localities of origin of the patients. All patients positive to Toscana virus lived, and thus possibly became infected, in human settlements located in the plane and in the surrounding hills along the river Arno, in a range of 10 Km northwest from the town of Florence.

Therefore, during 1980 a project was started to study the presence of vectors and foci of Toscana virus in the areas of possible infection of patients. Sandflies collections were made during summers 1980-1981 around the village of Sesto Fiorentino, where it was found the highest sandflies population density. Sandflies were captured by direct aspiration from their resting places, mainly inside poultry houses. After collection, the insects were transported alive to our field laboratory in Florence and subsequently delivered on dry ice to Rome where they were stored at - 70°C until being processed. At that time, the insects were separated by sex and samples were used for species identification. All insects were Phlebotomus perniciosus. (Collection and identification of arthropods were done by M.Coluzzi and G.Sabatinelli of the Institute of Parasitology of the University of Rome).

Table 2 summarizes sandfly collections and virus isolation results. A total of 609 sandflies (467 females and 142 males) was processed as 31 pools for virus isolation. From these a total of 9 virus strains were obtained. Five isolates have been identified by HI, CF and PRN tests as Toscana virus. Four isolates failed to react in HI, CF and PRN tests with antisera to Toscana and to the related SFN virus. They were shown to be identical by CF test and are listed in the table by the prototype number (ISS.Ph1.18). This virus was compared by CF test with MIAFs Group Phlebotomus fever, Group A and Group B, and its identification is still in progress. One positive sandfly pool yielded both Toscana (in VERO cells) and ISS.Ph1.18 (in newborn mice) viruses. Each of the viruses was isolated in both years. Two isolates (one each of Toscana and ISS.Ph1.18 viruses) were obtained from pools of male sandflies collected during the summer 1981. These findings, although new for Toscana virus, are in agreement with similar data obtained with other Phlebotomus fever group viruses isolated in old and new world.

It is remarkable the number of viral agents isolated from a relatively small number of sandflies: it represents an infection rate of one isolate per 67 sandflies processed. Similar high rate of infection was found in sandflies of the same species yielding the prototype strains of Toscana virus collected in Monte Argentario (Grosseto province).

It has been reported a greater sensitivity of VERO cells for primary isolation of Phlebotomus fever group viruses from sandfly suspensions, in comparison with suckling mice inoculation. We inoculated each insect pool simultaneously into both isolation systems. As shown

in Table 3, VERO tube cultures seem to give better results with Toscana virus, although one isolate was obtained from suckling mice but not in VERO. However, during reisolation attempts on the original insect suspension, this isolate was reisolated in VERO cell culture.

In addition to sandfly collection, mosquito collections were made at 18 sites throughout the same area between July and September during 1980 and 1981. Collections were chiefly made by direct aspiration from their resting places in 1980, and also using CDC light and animal bait traps during 1981. Culex pipiens species was prevalent, but also Aedes vexans, Anopheles maculipennis and A. claviger were found. Approximately 4,500 mosquitoes altogether were collected during the two years. They were pooled by species and tested for virus. No virus was demonstrated in tissue cultures; mouse-adaptation for two pools is still in progress.

In order to study a possible role of animals in the epidemiology of Toscana virus, during July and August 1981, 6 sentinel animals (2 chicken, 2 pigeons, 2 rabbits) were exposed at the virus isolation sites. Blood samples were collected monthly from all sentinels and the sera were tested for antibodies to both Toscana and ISS.Ph1.18 by HI, but no seroconversions were detected.

( P.Verani, M.G.Ciufolini, L.Nicoletti and M.Balducci<sup>+</sup> )

<sup>+</sup>Field Epidemiologist, Toscana Region

TABLE 1. Monthly distribution of CNS patients serologically positive to Toscana virus

Month	No. of patients <sup>+</sup>	No. of Toscana positives <sup>++</sup>	Percentage of Toscana positives
January	9	0	-
February	7	0	-
March	16	0	-
April	8	0	-
May	9	0	-
June	18	2	11.1
July	20	6	30.0
August	14	4	28.5
September	8	3	37.5
October	11	1	9.0
November	9	0	-
December	3	0	-
Total	132	16	12.1

<sup>+</sup> Cases occurring between 1977-1980

<sup>++</sup> Seroconversions by HI and/or CF and/or PRNT

TABLE 2. Virus isolations from Phlebotomus perniciosus,  
Florence province

Collection period	No.sandflies processed	No.of isolates		
		Toscana	ISS.Ph1.18	Total
1980 July	148	2 (1.3) <sup>+</sup>	2 (1.3)	4 (2.7)
August	117	1 (0.8)	0	1 (0.8)
1981 July	61	0	0	0
August	259	2 (0.8)	2 (0.8)	4 (1.5)
September	24	0	0	0
Total	609	5 (0.8)	4 (0.6)	9 (1.5)

<sup>+</sup> (isolation rate per 100 sandflies)



TABLE 3. Viruses isolated from sandflies according to isolation systems

Isolation system		Number of isolates		
VERO	Suckling mice	Toscana	ISS.Ph1.18	Total
+	+	2	3	5
+	-	2	0	2
-	+	1	1	2
Total		5	4	9

Morphologic characterisation of the ungrouped virus Oubangui ArB3816

A number of ungrouped viruses were recently investigated by Electron Microscopy and morphologically characterised (1).

Oubangui ArB3816, originally isolated from Culex guiarti and supplied to us in suckling mice by Dr. JP Digoutte, Pasteur Institute Bangui, was subsequently passed 4 times in suckling mice. Mouse brain harvests were tested in different cell lines, but failed to show the presence of any virus particles (1).

The fourth passage of the virus was subsequently passed in new born mice again, brain, liver and spleen were harvested and the latter two were cocultivated with vero cells. Poxlike virusparticles were detected in the supernatant of brain organ cultures and cocultivated liver/vero and spleen/vero cells.

Further characterisation of the virus will be performed by Dr. Nakano (U.S.A.) and Dr. Maltseva (U.S.S.R.).

(1) Trans R Soc Trop Med Hyg 1981; 75 (6): 612.

G van der Groen and A El Mekki

REPORT FROM THE VIRUS LABORATORY  
Faculty of Medicine  
Brest, France

STUDIES ON ARBOVIRUS INFECTIONS IN MOROCCO

Information on arbovirus infections in Morocco were quite scarce (Nejmi, 1980) in despite this country is located between West Africa and South West Europe and is concerned by passages of many migrating birds between palearctic and ethiopian areas. Furthermore, in the recent years, two major animal pathogens, blue tongue and african horse sickness type 9 arboviruses were though possibly imported in South Europe from infected foci of Maghreb by windborne spread (Sellers et al, 1977, 1978).

We present some results of limited arbovirus surveys carried out in this country, since 1979.

1. SEROLOGICAL EVIDENCE OF ARBOVIRUS INFECTIONS IN SMALL MAMMALS

*Methods*

During entomological survey in the North of Morocco ("Rif" area), March 1979, 128 small mammals (rodents, insectivora) were trapped alive and their blood collected on clotting papers. Specimens were obtained from six different species and from three provinces (5 stations): Chaouen, Kenitra and Tanger (see Map).

Serosurvey was carried out by IH or CF using micromethods and the following antigens: Sindbis, West Nile, Tick-borne encephalitis (european type), dengue type 2, Wesselsbron, Tahyna, Uukuniemi, Bhanja, Tribec, Arumowot, Sicilian sandfly fever, Qalyub, Quarafil, Brest/Ar/T222 (Kemerovo group) and Brest/Ar/T234 (Soldado-like).

These two later viruses were from *Ornithodoros (Alectorobius) maritimus* ticks associated with herring gulls at Essaouira, Morocco.

For IH tests, non-specific inhibitors were removed by acetone. In CF tests, only 94 sera were tested.

*Results*

No antibody was found against Sindbis, Wesselsbron, Tick-borne encephalitis, dengue type 2, Bhanja, Uukuniemi, Tribec, Qalyub and Soldado viruses.

On the other hand, positive reactions were observed against West Nile (one serum of *Mus spretus* at 1:20 from Arbaoua, Kenitra), Tahyna, Arumowot, Sicilian sandfly fever, Quarafil and T222 viruses.

The IH titers ranged from 1:20 to 1:2,560 for Tahyna, from 1:20 to 1:80 for Arumowot and from 1:20 to 1:160 for Sicilian sandfly fever. Both multiple and monospecific reactions were observed.

On the whole, 36% of sera were positive with some variations according to the place of collection and to the species of small mammal (Table 1).

Finally, positive reactions occurred in all the species of rodents or insectivora surveyed. However *Apodemus sylvaticus* reacted with 5 antigens and *M. spretus* with 4; positive reactions for Arumowot only were seen in *M. musculus*, *Eliomys quercinus* and *Crocidura russula*. *Rattus rattus* reacted only with Tahyna. One unique serum of *A. sylvaticus* from Ain Rami, Chaouen, reacted simultaneously with Quarafil (1:32) and T222 (1:8) on CF test.

#### Comments

NT antibodies against Sicilian sandfly fever were previously found by Tesh et al (1976) in human sera at Midelt-Itzen (5.7%), about 300 km southward our stations of trapping. Accordingly it is not too surprising that positive reactions against this phlebovirus may be found in rodents of Morocco, especially as sandflies are widely distributed in this country (Bailly-Choumara et al, 1971, 1976), though *Phlebotomus papatasi* was not found in "Rif" area.

For the other arboviruses, no report is available about their eventual circulation in Morocco. Arumowot is a phlebovirus widely dispersed in tropical Africa with numerous isolations from *Culex* mosquitoes, rodents and *Crocidura* sp. in Sudan, RCA and South Africa. During the serosurvey of Tesh et al (1976), no NT antibody against Arumowot was found in human sera but 8.6% of the same sera neutralized Sud An 754-61, another phlebovirus from Sudanese rodents. So, either Arumowot really circulate among small mammals in Morocco or cross reactions with Sud An 754-61 or Sicilian sandfly fever may account for positive Arumowot reactions.

CF antibodies against Quarafil, a not classified virus from *Argas arboreus* and *A. hermanni*, were found in human sera and in 2.7 to 28.5% of rodent sera, in Egypt (Abdel-Wahad and Iman, 1970; Darwish and Hoogstraal, 1981).

CF antibodies against Brest/Ar/T222, a tick-borne virus associated with seabirds may be explained by antigenic relationship among Kemerovo group viruses.

Tahyna virus, a mosquito-borne arbovirus, is widely distributed in all the mediterranean area, particularly in Spain and Portugal. So, the possible activity of this virus in North Morocco is not unlike.

## 2. NEW ISOLATIONS OF TICK-BORNE ARBOVIRUSES FROM SEABIRDS COLONIES

During the spring of 1981, 122 *O. (A.) maritimus* ticks were collected in colonies of herring gulls (*Larus argentatus michaellis*) at Kala Iris, an islet of the mediterranean coast of Morocco. Six strains of a Kemerovo group virus were isolated from female or nymph pools.

Preliminary results of CF tests indicated all these strains were identical to each other and to Brest/Ar/T222 isolated in 1979 at Essaouira (§1, methods), on the atlantic coast of the country. Exchanges of gulls probably occur between these two seabirds colonies.

### 3. NATURAL PATHOGENICITY FOR MAN OF AN ANTIGENIC VARIANT OF SOLDADO VIRUS ISOLATED FROM MOROCCO

Pathogenicity of Soldado virus was strongly suspected from reports of nest desertion and abnormal development of young seabirds in colonies infested by viruliferous ticks in Seychelles, Texas, etc... However, pathogenicity for man of Soldado virus remained questionable.

In a scientist, repeatedly bitten by *O. (A.) maritimus* larvae at Essaouira, the association of fever of unknown origin and of NT antibodies against a Soldado-like virus (Brest/Ar/T234) isolated from the same tick and the same place, lead to the conclusion that this virus may act as a pathogen for man. Parallelism with Zika or Punta Salinas viruses infections in man was evident.

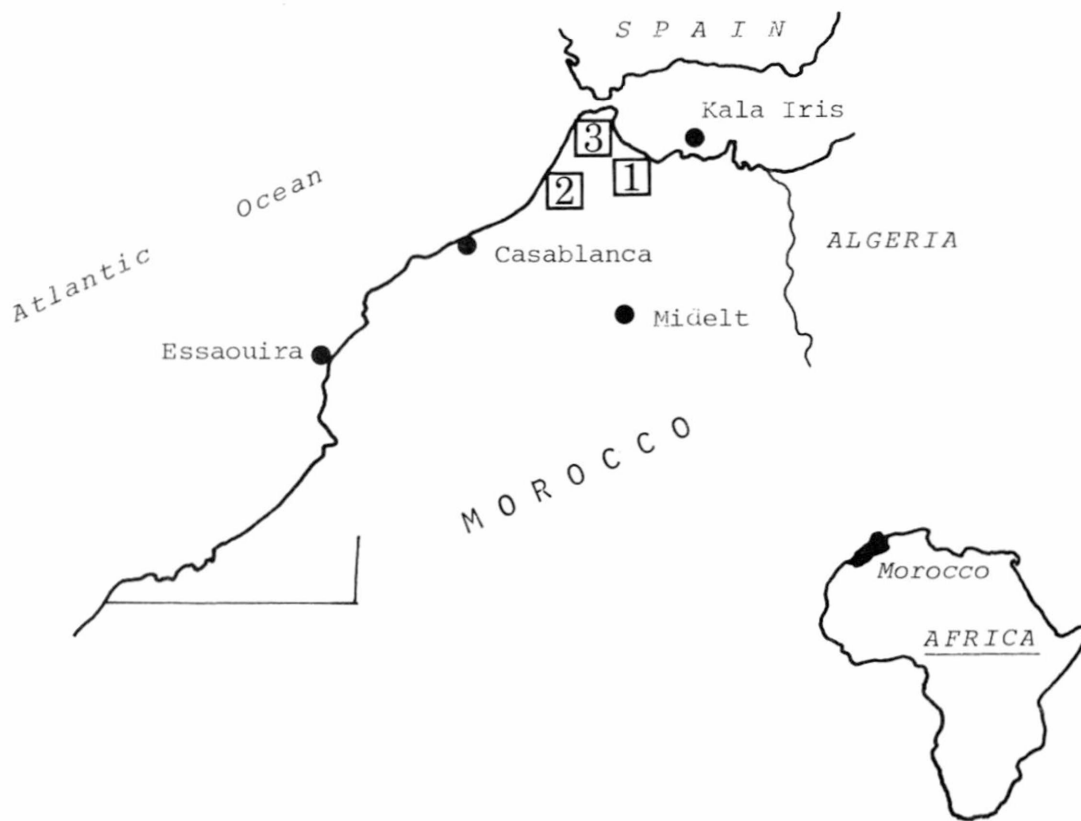
However, it is clear that Soldado virus infection in man is only possible in individuals at risk, i.e., ornithologists, entomologists, scientists, "ringers" (Nuttal, 1980) or eventually island inhabitants acting as predators of seabirds for food or feathers (in C. Chastel, H. Bailly-Choumara and G. Le Lay, Bull. Soc. Path. exot., Paris, 1981, 74, 499-505).

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H. Bailly-Choumara, "Institut Scientifique", Rabat, Morocco.

H. Launay and J.C. Beaucournu, Medical Entomology, Faculty of Medicine,  
Rennes, France.

G. Le Lay and C. Chastel, Virus Laboratory, Faculty of Medicine, Brest,  
France.



### **1** CHAOUEN

- Chaouen (AMT-T222-QRF)
- Bab-Besen (TAH, AMT)
- Talembote (TAH-AMT, SSF)

### **2** KENITRA

Arbaoua (WN-TAH-AMT, SSF)

### **3** TANGER

Asilah (TAH-SSF)

MAP OF MOROCCO

PROVINCE:	Chaouen		Kenitra		Tanger		Total			Antigens concerned by positive reactions
SPECIES:	Tested	Positive	Tested	Positive	Tested	Positive	Tested	Positive	%	
RODENTIA										
<u>Muridae</u>										
<i>Apodemus sylvaticus</i>	57	16	31	9	8	5	96	30	31.2	TAH-SSF, AMT-T222-QRF
<i>Mus spretus</i>	3	1	11	7	3	3	17	11	64.7	TAH-SSF, AMT-WN
<i>Mus musculus</i>	1	1					1	1		AMT
<i>Rattus rattus</i>	1	0	3	2			4	2		TAH
<u>Gliridae</u>										
<i>Eliomys quercinus</i>	1	1					1	1		AMT
INSECTIVORA										
<u>Soricidae</u>										
<i>Crocidura russula</i>	6	1	2	0	1	0	9	1	11.0	AMT
TOTAL	69	20	47	18	12	8	<u>128</u>	<u>46</u>	<u>36.0</u>	

Table 1. Arbovirus survey in blood of small mammals, North-Morocco, 1979.

REPORT FROM THE LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, ARBOVIRUS RESEARCH UNIT, 395 HATFIELD ROAD, ST. ALBANS, HERTS, ENGLAND, AND \*PHLS CENTER FOR APPLIED MICROBIOLOGY AND RESEARCH, SPECIAL PATHOGENS REFERENCE LABORATORY, PORTON DOWN, SALISBURY WILTSHIRE, ENGLAND.

### Preparation and Properties of Monoclonal Antibodies to Japanese Encephalitis Virus

Five monoclonal antibodies to Japanese encephalitis (JE) virus were prepared from hybrid cell lines of Ag8-653 and Balb/c mouse spleen cells as described by Chanas et al (1982). Each antibody produced immunofluorescence in the cytoplasm of both acetone-fixed JE infected and West Nile (WN) infected Vero cells (clone C1008) though the pattern of immunofluorescence was different for each clone. Their sub-class specificities were identified by Ouchterlony gel-diffusion with sub-class specific antiglobulins and were as follows:- clones 4, 12, 15, 18 and 23 were IgM, IgG3, not yet identified, IgG3 and IgG2a respectively. Only clone 12 showed definite haemagglutination inhibition (HI) activity and neutralization activities although clone 18 had low titre HI activity. Analysis of radioimmuno-precipitates from <sup>35</sup>S-methionine labelled infected cell extracts on 8-15% acrylamide gradient gels showed that clones 12 and 23 reacted specifically with a major virus-specified protein of molecular weight 54,000, probably the envelope glycoprotein V3.

Monoclonal antibody 4 produced virus-specific diffuse cytoplasmic fluorescence and also stained small inclusions in the nuclei of both non-infected and infected Vero cells, primary mouse embryo fibroblasts (To and Balb/c strains) P.S. cells, MDCK cells and primary human MRC5 cells whereas the nuclei of Xenopus laevis (XL-2) cells did not contain the appropriate epitope. The determinant is therefore common to a wide range of mammalian cells and it appears that the Balb/c mouse used for the monoclonal antibody production elicited an autoantibody type of response. In addition both heat-inactivated and native clone 4 antibody produced an unusual prozone effect when tested by immunofluorescence at high concentrations. This type of interference has been seen by us with monoclonal antibodies prepared against other viruses and together with the anti-cellular effects is being investigated in more detail.

#### Reference.

Chanas, A.C., Gould, E.A., Clegg, J.C.S. and Varma, M.G.R. (1982). Monoclonal Antibodies to Sindbis Virus Glycoprotein E1 can Neutralize, Enhance Infectivity, and Independently Inhibit Haemagglutination or Haemolysis. J. Gen. Virol. In press.

(E.A. Gould, A.C. Chanas, J.C. Clegg\* and M.G.R. Varma)



BLUETONGUE

In 1980 we published results on the distribution of bluetongue viruses and antibodies in some countries of the Eastern Hemisphere (Bull. Off. int. Epiz., 1980, 92, 581-586). Results were given under six headings:-

- (a) Whether disease had been seen in local or imported sheep
- (b) The types of virus isolated
- (c) Significant rise in antibody (four-fold or greater) to the type of virus concerned
- (d) Presence of antibody of titre 1/80 or greater to a single type in a single animal
- (e) Presence of antibody of titre 1/80 or greater to more than one type in a single animal
- (f) Positive result in the agar gel precipitin test.

We have since examined sera from other countries under (d), (e) and (f), with the following results:-

Country	Species	Serum virus neutralisation test		
		High-titre antibody ( $\geq$ 1/80) to one type in a single animal	High-titre antibodies to more than one type in a single animal	Agar gel precipitin test
THAILAND	Sheep	2, 12	-	+
	Cattle	2, 4, 16	2, 12, 16, 20	+
	Goats	-	-	+
	Buffalo	2, 9, 12	2, 11, 17	+
ARGENTINA	Cattle	-	-	-
PARAGUAY	Cattle	2, 13, 16	-	+
VENEZUELA	Cattle	2, 9, 13, 16	9, 12, 13, 16	+
BARBADOS*	Sheep	1, 6	1, 2, 6	+
ST. VINCENT*	Goats	14	3,4	+
	Cattle	14, 15		+

\*Antibodies (1/40) were found to types 5, 10 (Barbados) and 1, 2, 5, 6, 15, 20 (St. Vincent)

High-level antibody to one type may mean that the animal had been infected with that type. Where, however, there are high-level antibodies to more than one type, it is difficult to be certain whether all or a few or one of the types are present. In a number of instances, both at the centres given and in other parts of the world, we have detected AGP antibodies without being able to detect antibody to any particular type. This may mean that bluetongue viruses other than types 1-20 are circulating.

The results from South America and West Indies indicate that type 13 is the only circulating virus in common with North America.

I.D. Gumm, K.A.J. Herniman, L. Owen, R.F. Sellers, W.P. Taylor

Orbi- and bunyaviruses from a seabird colony in Scotland

Viruses were isolated from 3 pools of ticks (*Ixodes uriae*) and from a kittiwake (*Rissa tridactyla*) from a seabird colony at St Abb's Head (Table 1).

All the isolates except FT363 produced strong cross-reactions in complement fixation tests (Table 2). Complement fixation tests were also performed with Clo Mor immune ascitic fluid (AF) obtained from the Yale Arbovirus Research Unit, and with the following immune AF obtained from the US National Institute of Allergy and Infectious Diseases (Bethesda, Maryland): Groups A, B, Bunyamwera, California Kemerovo, Phlebotomous, Simbu, Tacaribe, VSV; polyvalent Anopheles group, Bwamba, Congo, Palyam, Patois, Quarantil, Rabies etc, 1 (Bahig etc), 2 (Jurona etc), 3 (Koongol etc), 4 (Nyamanini etc), 5 (Hughes etc), 6 (Marco etc), 7 (Hart Park etc), 8 (Epizootic haemorrhagic disease of deer etc), 9 (Navarro etc), 10 (Upolu etc), 12 (Okula etc); Capim and Guama.  $\beta$ -propiolactone treated Chenuda and Uukuniemi viral antigens were used as positive controls. All 4 isolates cross-reacted with the Kemerovo serogroup, and all except FT363 cross-reacted with the Uukuniemi serogroup. None of the isolates reacted with the other reference immune AF tested.

The viruses replicated in several different cell lines including BHK, Vero, and chick embryo fibroblasts. Electron microscopic examination of cell cultures infected with the Kemerovo group viruses revealed particles characteristic of orbiviruses and, with the Uukuniemi group viruses, bunya-like virus particles (Arthropod-borne Information Exchange, March 1980). The orbiviruses produced plaques in Vero and not in *Xenopus laevis* cell cultures whereas the bunyaviruses produced plaques in *Xenopus* and not in Vero cell cultures.

The bunyaviruses showed extensive cross-neutralisation when compared by plaque reduction neutralisation tests, and did not react with AF raised against FT363 (Table 3). In contrast, the orbiviruses in each of the 4 isolates showed varying degrees of cross-neutralisation. Isolates FT254, GM710 and M349 cross-reacted although the neutralising titre of AF raised against GM710 was 16 times greater with GM710 than with FT254 and M349 orbiviruses. Isolate FT363 showed one-way cross-neutralisation: AF raised against FT363 neutralised the other isolates whereas AF raised against the other isolates did not give significant neutralising titres with FT363 virus. Thus, at least 2 antigenically distinct orbiviruses appeared to be present: one virus in isolates FT254 and M349, a second in FT363, and possibly a third in GM710.

The isolates examined were collected over a period of 5 years. The results show that St Abb's Head represents a persistent focus of mixed virus infections.

(P.A. Nuttall, K.A. Harrap, H. Reid\*, D. Carey, S. Moss)

\* Moredun Research Institute, Edinburgh.

TABLE 1

Source of virus isolations

Code No	Collection date	Source	Viruses isolated
FT254	17.12.74	22 ♂ <u>I.uriae</u>	orbi- + bunyavirus
FT363	27.07.75	10 engorged nymphs <u>I.uriae</u>	orbivirus
GM710	27.07.75	kittiwake brain and blood	orbi- + bunyavirus
M349	27.09.79	20 engorged nymphs <u>I.uriae</u>	orbi- + bunyavirus

TABLE 2

Comparison of the different isolates by complement fixation tests

mouse brain antigens	immune ascitic fluids					
	FT254	FT363	GM710	M349	KEM**	polyvalent 4†
FT254	320/40*	5/40	160/40	160/40	32/10	16/40
FT363	5/40	80/40	5/40	5/40	64/10	< 2/10
GM710	10/40	5/40	32/40	20/40	16/10	16/40
M349	80/40	<5/10	80/40	40/40	<4/10	16/20
Chenuda	32/4	32/4	32/4	32/4	512/4	-
Uukuniemi	64/32	<8/32	16/32	32/32	-	512/32

\* reciprocal of ascitic fluid titre/reciprocal of antigen titre.

\*\* Kemerovo, Chenuda, Mono Lake, Wad-Medani, Tribec, Huacho.

† Uukuniemi, Nyaminini, Grand Arbaud, Thogoto.

TABLE 3

Comparison of the different isolates by neutralisation tests

Antigen	Immune ascitic fluid			
	FT254	FT363	GM710	M349
FT254	64*, <u>256</u>	32, < <u>4</u>	32, <u>64</u>	64, <u>64</u>
FT363	4	512	8	4
GM710	64, <u>256</u>	128, < <u>4</u>	512, <u>128</u>	32, <u>128</u>
M349	16, <u>256</u>	32, < <u>4</u>	32, <u>256</u>	128, <u>256</u>

\* reciprocal of dilution of ascitic fluid which produced a 50% reduction in number of plaques compared with the control, untreated virus. Titres with either the orbivirus in infected Vero cell cultures or the bunyavirus in infected Xenopus cell cultures (titres underlined).

REPORT FROM KIMRON VETERINARY INSTITUTE,  
P.O.B. 12, Bet-Dagan 50250, Israel

PRELIMINARY STUDIES ON THE REPLICATION OF INFLUENZA VIRUS IN MOSQUITOES

Blood-sucking arthropods are known as potential carriers of arboviruses. Cell lines prepared from insect and tick tissues are susceptible to infection with arboviruses. There have been only a few successful attempts to show multiplication of other groups of viruses in insect and tick tissues (Rehacek, 1965, 1971; Gillies and Stollar, 1981). In this respect myxoviruses are of particular interest, especially influenza viruses which attack regularly both humans and mammalian (mainly pigs and horses) and avian (feral and domestic) species causing epidemics and pandemics on one hand, and epizootics on the other hand. Such diversity of hosts of influenza viruses raises a question whether arthropods are involved in the transmission or natural circulation of influenza viruses. Only one attempt to show multiplication of influenza virus in mosquito (Aedes aegypti), after intrathoracical inoculation was undertaken. (Kulkeva and Solouhin, 1979). However, the method for detection of the virus in mosquitoes which was used in these studies did not seem to give definite results demonstrating virus multiplication.

In the present studies intrathoracical inoculation of mosquitoes of the most common species in Israel, Culex pipiens molestus Forskal was used and the detection of the virus was followed by means of both titration of infectious virus in chick embryonated eggs and determination of virus-specified neuraminidase (Nase) activity. Since the optimal dose of inoculated virus was not known, two 20-fold times differing concentrations of the inoculated virus ( $1.2 \times 10^8$  chick embryo infectious doses ( $\text{EID}_{50}/\text{ml}$ ) and  $2.5 \times 10^9$   $\text{EID}_{50}/\text{ml}$ ) were used. As an average volume of virus suspension inoculated per mosquito was  $0.41 \mu\text{l}$  the actual doses per mosquito appeared to be  $5 \times 10^4$   $\text{EID}_{50}$  and  $1 \times 10^6$   $\text{EID}_{50}$ , respectively.

Inoculation was performed with a simple apparatus similar to that described by Mueller and Rochow (1961). The inoculated mosquitoes were kept in an insectary at temperatures of 25 to 29°C and fed with 10 per cent sucrose solution. At certain

intervals (0,4,7,10,14,21 and 28 days) post inoculation (p.i.) 25 mosquitoes were taken at random, frozen immediately at  $-70^{\circ}\text{C}$  and kept in this condition until used for virus detection. The samples were thoroughly homogenized, using Potter-Elvehjem homogenizer with a motorized teflon pestle, in 2.5ml of (phosphat buffered saline). In each sample the infectious titre was determined on chick embryonated eggs using the Reed and Muench (1938) method of calculation and Nase activity was determined by thiobarbituric method (Warren, 1959) with the modification of Aminoff (1961). The results showed a significant increase in the infectious titre of the virus derived from the homogenates with progressive time p.i. At time of inoculation, there was a certain titre of infectivity ( $3-30 \text{ EID}_{50}/\text{ml}$ ) which was evidently due to input virus. At 4 days p.i. this titre dropped to an undetectable level which seems to be analogous to the "eclipse" phase of the virus multiplication cycle in mammalian and avian cell cultures. Within the period of 4-7-10 days p.i., there appeared a significant increase in the infectious titre up to  $3 \times 10^2 - 3 \times 10^3 \text{ EID}_{50}/\text{ml}$ , this titre being sustained till 14 days p.i. At that time a drop of the infectious titre to  $3 \text{ EID}_{50}$  was recorded and at 28 days p.i. no virus was detected. Nase activity of the homogenates, however, showed no correlation with the curves related to the infectious titre. The Nase activity of the homogenate preparation taken at zero time was the highest value recorded after which there was a gradual decrease (without "eclipse" at 4 days p.i.) until at 7 days p.i. when the decrease became more evident.

The results, therefore, seem to show the multiplication of influenza virus in mosquitoes after intrathoracical inoculation of the virus. The presence of the "eclipse" phase with no detection of infectious virus which was followed by detection of increased amounts of infectious virus demonstrates accumulation of newly reproduced virus rather than just survival of the input virus. Final decrease of the infectious titre until its disappearance seems to show the presence of a certain reproductive cycle which is significantly slower than that occurring in mammalian and avian cells.

Contrary to the results with the infectious virus, the Nase activity, which was shown to be gradually decreasing along with the time p.i., seems to be due to that of the input virus. If this is the case the loss of infectivity of the input virus ("eclipse" phase) proceeds at a considerably higher rate than the loss of the input virus Nase activity. Two possible explanations of the failure to detect newly formed Nase can be suggested: (a) de novo synthesis of Nase in mosquito cells is blocked, or (b) de novo synthesis of the Nase-specific protein occurs but the "functional maturation" of the synthesized polypeptides (acquisition of enzymatic properties) is blocked. The findings presented here are preliminary results since many technical details have yet

to be perfected. In particular, the dose of the inoculated virus (together with some other uncontrollable factors) seems to be a very critical step determining the reproducibility of the results. Since intrathoracical inoculation of mosquitoes is an artificial way of virus administration a further aim is to study the possibility of multiplication of influenza viruses in the cells of the intestine tract following administration of an infected blood meal.

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M. Lipkind, Y. Braverman, K. Frish and E. Shilmanter



REPORT FROM THE ARBOVIRUSES LABORATORY

INSTITUT PASTEUR  
01 B.P. 490  
ABIDJAN - IVORY COAST

RAPID IDENTIFICATION OF ARBOVIRUSES BY A NEW TECHNIQUE ASSOCIATING  
GEL FILTRATION CHROMATOGRAPHY AND AN IMMUNOENZYMATIC TEST (E.L.I.S.A.)

Potential arboviruses vectors are collected for arboviral surveillance. Every batch to be tested is inoculated intra-cerebrally to suckling-mice. As soon as paralytic signs appear, a rough brain extract is prepared by grinding, diluted in phosphate buffer and centrifuged (5000g).

The supernatant is applied on an agarose gel column and the gel excluded viral particles are eluted in less than half an hour by phosphate buffer saline at +4°C.

A microtitration polystyren plate for E.L.I.S.A. reaction is immediately coated with the fraction containing viral antigen. Antigen fixation occurs indistinctly one hour at +37°C or overnight at +4°C. After plate washing, E.L.I.S.A. test is performed by adding step by step specific mouse hyperimmune ascitic fluids and mouse anti-IgG conjugate with peroxidase. Positive reaction is revealed by a very sensitive chromogen substrate containing ortho-tolidine.

The advantages of this technique are :

- its specificity, at least equal to that of the complement fixation reaction;
- its simplicity and convenience for field conditions.  
First, the use of a lipoprotein stain, Red Oil O, visualises the elution fraction which contains the viral antigen and makes the fractions collector useless.  
Moreover, the spectrophotometer is not necessary there the intensity of coloration due to ortho-tolidine stands quite in contrast with back-ground and enables visual reading.
- its economic conditions, especially in suckling-mice : only one is used for the rough brain extract preparation;
- and last but most valuable :  
the identification of an arbovirus is attainable in half a day and this from the first passage in suckling-mice, without the need of adapting the strain.

This new technique permits closer epidemiologic surveillance, especially in tropical regions, providing that inoculations are performed early after the *Culicidae* are caught.

M. LHUILLIER, J.L. SARTHOU, N. MONTENY, G.M. GERSHY-DAMET,  
V. AKRAN, N. ARON, B. DIACO - Institut PASTEUR  
(Director : Dr J.C. ARTUS)  
R. CORDELLIER, B. BOUCHITE - O.R.S.T.O.M.

ELECTRON MICROSCOPIC STUDIES ON THE MORPHOLOGY  
OF NAIROBI SHEEP DISEASE VIRUS

The morphology of extra- and intracellular Nairobi Sheep Disease virus multiplied in tissue cultures has been studied. Extracellular virus particles could be detected after direct sedimentation on electron microscope grids in a special ultracentrifuge ("air-fuge") and after negative staining. Sucrose gradient centrifugation and pelleting were found to be ineffective. Good results were obtained by immune-electron microscopy, but polyethylenglycol precipitation preserved the structures of the virus particles best. In ultrathin sections of infected sheep kidney tissue culture cells virus particles showed characteristics of other bunyaviruses with regard to localization, appearance and to the morphology of cell-free particles.

The morphological characteristics of Nairobi Sheep Disease virus can be summarized as follows:

shape: spherical (round, slightly oval in ultrathin sections  
occasionally pleomorphic after negative staining)  
size (average diameter): 110 nm (after negative staining)  
80 nm (in ultrathin sections)  
envelope: consists of a 5 nm wide electron transparent  
layer, covered with about 10 nm long bristle-  
like projections  
inner structures of the particles: fine granulated  
(negative staining) or irregular, amorphous  
material (ultrathin sections)

These results justify the integration of Nairobi Sheep Disease virus in the group of the bunyavirus-like arboviruses when seen from the morphological point of view.

(E. Munz, E. Goebel, Chr. Krolopp, M. Reimann and F.G. Davies\*)

REPORT FROM TANDIL VIRUS RESEARCH LABORATORY

FACULTY OF VETERINARY SCIENCES

NATIONAL UNIVERSITY OF CENTRAL BUENOS AIRES PROVINCE (UNCPBA) ARGENTINA

A survey with 1279 bovine sera from Tandil county (Buenos Aires Province, Argentina) was done against VSV (Indiana and New Jersey types) and Junin virus, (XJ strain). Complement fixation was used for all sera and neutralization test with a group of selected sera: the ones positive by CF plus sera from animals 10 year old or older.

Table I shows results of CF test by age and sex, none positive for VSI, 7 out of 1279 positive for VSNJ (0,55%) and 21 out of 1279 positive for Junin (1.64%). Ranges of positivity for VSNJ were from 1:4 (lowest dilution used) to 1:8 and for Junin from 1:4 to 1:32.

By NT (see table II) done in mice i.c route with 100 LD<sub>50</sub>, newborn (1-5 d. old) for Junin and adult for VSV results were positive only for VSV. With VSI 24 out of 91 (26,37%) were positive and with VSNJ 11 out of 92 (11,95%). Lack of neutralizing antibodies for Junin virus including the sera positive by CF is something we need to work on, since the same test works beautifully with experimental sera from mice and human sera from persons having Argentinian Hemorrhagic Fever many years ago.

Dres. Norma Mettler, Mónica Di Santo &  
Daniel Pardo.

Table I: Serological results by CF against VSV and Junin virus  
in bovine sera from Tandil county (Bs. As. Province - Argentina).

Test	Age (in years) and Sex														Total
Number of sera used with each antigen	0 < 1		1 < 3		3 < 5		5 < 7		7 < 9		9 < 11		> 11		all
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	both
	17	34	29	248	5	436	14	170	9	193	2	73	-	49	1279
VSI (SHNM)	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
VSNJ (Hazelhurst)	1	2	0	1	0	3	0	0	0	0	0	0	-	0	7
JUNIN (XJ)	1	6	1	9	0	3	1	1	0	0	0	0	-	0	21

Table II: Results of NT against 100 LD<sub>50</sub> i.c route in mice  
(newborn for Junin, adult for VSV)

Virus (strain)	Nº of sera Tested	Positive	Negative	% of Positive
VSI (SHNM)	91	24	67	26.37
VSNJ (Hazelhurst)	92	11	81	11.95
JUNIN (XJ)	65	0	65	0

REPORT FROM THE DEPARTMENT OF EPIDEMIOLOGY, LABORATORY OF ENTOMOLOGY, SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF SÃO PAULO, BRAZIL, SÃO PAULO, AV. DR. ARNALDO, 715, CEP 01255.

During 26 monthes, 25-hour catches of mosquitos were carried out twice a month with human bait, in a residual forest patch at Ribera Valley, São Paulo State, Brazil. Nine main species were separate according two activity patterns, diurnal and nocturnal, showed during the daily biting cycle. Nevertheless, even showing clear diurnal pattern, Aedes scapularis and Ae. serratus presented a good amount of activity during the nocturnal hours. Beside this, Ae. scapularis showed a clear peak of biting activity in the sunset crepuscular period corresponding to crep 0.5 - 1.0, sustaining the activity outside forest environment at an equivalent level to the inside one. So it seems that this mosquito has great opportunities of to come into contact with the human population, and so with good chance of to transmit arboviruses, particularly the encephalitis ones.

(Oswaldo Paulo Forattini, Almério de Castro Gomes, Jair Lício Ferreira Santos, Eunice Aparecida Bianchi Galati, Ernesto Xavier Rabello and Delsio Natal).

REPORT FROM ARBOVIRUS LABORATORY

INSTITUT PASTEUR  
B.P.304

97305 - CAYENNE CEDEX - FRENCH GUIANA

DENGUE IN GUADELOUPE , MARTINIQUE AND  
FRENCH GUIANA

Investigations were carried on to determine the dengue virus activity in Guadeloupe, Martinique and French Guiana by examination of human sera collected from august to december 1981.

Few specimens were submitted for virus isolation but four strains were isolated from human sera collected in Martinique and air mail to Cayenne on the same day.

The 4 strains were identified by the fluorescent inhibition method to dengue 4.

One dengue 1 virus was isolated from the blood of a patient with a dengue like illness in Cayenne, French Guiana.

Serological tests (Hi and CF) were done on serum specimens using 5 Flavivirus antigens : Yellow fever (FNV), Saint-Louis Encephalitis, dengue 2, dengue 3 and Ilheus. Dengue 4 antigens was too weak to be included in the test.

When a single serum sample was submitted, which is the rule, a titer of 1 : 64 or more with any of the antigen was considered as an indication of recent flavivirus infection.

1. GUADELOUPE.

Serum samples from 22 patients were submitted from august to december 1981. Results were as follows :

<u>Month</u>	<u>N° of patients</u>	<u>Sero conversion or FC Titer &gt; 1:64</u>
August	12	4
September	2	0
October	5	1
November	1	0
December	2	0

2. MARTINIQUE.

158 patients serum samples were studied during the same period with the following results :

<u>Month</u>	<u>N° of patients</u>	<u>Sero conversion or FC Titer &gt; 1:64</u>
August	61	16
September	57	18
October	21	10
November	14	7
December	5	2

Serum samples from 200 patients were submitted to the laboratory.  
Results were as follows :

<u>Month</u>	<u>N° of patients</u>	<u>Sero conversion or FC Titer &gt; 1:64</u>
August	34	3
September	41	4
October	45	3
November	38	5
December	42	5

In addition, 1 strain of dengue 1 virus was isolated in July 1981.

(Y.ROBIN, G.GIRAULT).

REPORT FROM THE VIROLOGY SECTION OF THE INSTITUTO DE INVESTIGACIONES CLINICAS  
FACULTAD DE MEDICINA. UNIVERSIDAD DEL ZULIA. APARTADO POSTAL 1151. MARACAIBO  
VENEZUELA.

SEROLOGICAL STUDY OF CHILDREN FROM THE DISTRITOS MARA Y PAEZ FROM THE GUAJIRA  
VENEZOLANA TO INVESTIGATE ANTIBODIES TO VENEZUELAN EQUINE ENCEPHALITIS VIRUS.

Since 1973, the latest known epidemy of VEE virus in the Venezuelan Guajira,  
no cases of VEE virus has been reported in this area. Being VEE virus a cyclic di-  
sease, we worry about the possibility of a new incursion of the virus knowing that  
the population of the area has not been exposed to the virus since 1973.

A serological survey of children born after 1973 was done to know the immunity  
for the VEE virus.

550 serum samples from children between 5 and 7 years from the Distritos Mara  
y Páez de la Guajira venezolana, were taken between april and june 1981, and tested  
for HI antibodies to VEE virus.

As seen in the table none of them presented antibodies to VEE virus. From the  
two positives from Isla de Toas no information was possible to obtain.

SEROLOGICAL SURVEY IN CHILDREN UNDER 7 YEARS OF AGE FROM THE GUAJIRA VENEZOLANA  
TO DETECT ANTIBODIES TO VENEZUELAN EQUINE ENCEPHALITIS VIRUS. APRIL-JUNE 1981.

COMUNITY	Nº SAMPLES	POSITIVES
CARRASQUERO	30	-
PARAGUAIPOA	90	-
SINAMAICA	46	-
SAN RAFAEL DE MARA	120	-
SANTA CRUZ DE MARA	164	-
ISLA DE TOAS	79	2
ISLA DE SAN CARLOS	21	-
TOTAL	550	2

Another studies in equidae from the same area demonstrated lack of antibodies  
to VEE virus. These results plus our, indicate that the virus has not been present  
in the area since 1973, and the population is exposed to a new incursion of the virus.

(DRA. SLAVIA RYDER)



REPORT FROM THE GORGAS MEMORIAL LABORATORY,

PANAMA CITY, REPUBLIC OF PANAMA

I. Arbovirus Antibody Survey in Humans of the Tabasara-Vigui River Basin

Between April and August 1981, we carried out an arbovirus antibody survey on the human population of the Tabasara and Vigui River Basins in Western Panama. The survey formed part of a biomedical environmental impact evaluation for the proposed Tabasara Hydroelectric Project. The study area consists mostly of pasture and agricultural lands with gallery forest along the river banks. Elevation ranges from sea level at the mouth of the Tabasara River and the adjacent coasts to approximately 500 m in the upper reaches of the water shed. The population of the survey area was 10,883 with Indian groups (mostly Guaymi) comprising about 52% of the total inhabitants. Nineteen communities were visited and as many of the residents as possible from each community and its environs were bled. Since almost nothing was previously known about arboviruses in this region of Panama, we included in the survey 16 arboviruses which had been isolated in Panama and which are capable of causing illness in man. Plaque neutralization tests, using a single serum dilution (1/8) vs. a constant virus dose (40 to 150 PFU), were carried out in Vero cell cultures grown in 96-well disposable trays. Positive reactors (>90% plaque neutralization) were confirmed by titration in a second test.

All 2980 sera from the 19 localities were screened against 3 viruses: VEE (I-D), SLE and ILH. A systematic 1-in-4 subsample of 734 sera was tested vs. the other viruses: EEE, Mayaro, Bussuquara, Guaroa, Ossa, Madrid, Punta Toro, Chagres, Panamanian isolates belonging in the California, Guama and Wyeomyia complex groups and two vesicular stomatitis serotypes, Indiana and New Jersey. None of the sera had antibodies to EEE, BSQ, Ossa, Madrid or Guama group virus. Only one of 734 sera had antibody to Wyeomyia and only 2 of 734 to Chagres virus. Prevalences of the other nine viruses studied appear in Table 1.

Activity of enzootic VEE virus was quite limited, overall prevalence being 0.8%. Rates increased with age but only 4.0% of persons >50 yrs. had antibodies. Activity was scattered geographically; higher activity was found in the sector near the Pacific Ocean where both flooded rice fields and mangrove swamps lie close to the population centers.

SLE and ILH viruses showed somewhat greater activity than VEE virus in the human population - 2.8 and 1.7% prevalence, respectively. SLE activity was found in all but one of the 19 areas studied, while ILH was quite focal being especially active in the Pacific coastal lowland area. Continuing low level enzootic - endemic activity of both appears to occur. Several small children were found to have antibody, while prevalence reached 10.5% for SLE and 11.0% for ILH among the oldest age group ( $\geq 50$  y.o.).

Only 1.6% of the population had antibodies to Mayaro virus and 2.0% to Guaroa. Age distribution suggested possibly a very low endemic incidence of infection with Mayaro virus, building to 7.3% prevalence among persons  $>50$  y.o., but past epizootics could not be ruled out. On the other hand, since Guaroa antibody was not found in anyone under 30 yrs. of age, and antibody prevalence jumped from 4.1% among persons 30-49 y.o. to 16.4% among those  $>50$  y.o., it is likely that an epidemic or epidemics occurred in the past.

Overall antibody prevalence for California virus was 2.0%. The locality with the greatest activity in the present study was in the coastal lowland. Punta Toro virus (Phlebotomus fever group) was also only mildly active (1.8%). Prevalence increased with age, attaining 10.9% among those 50 yrs. and over. Continuing low level endemic activity appears to occur.

Both Indiana and New Jersey VSV are highly endemic in the region with overall prevalences of 43.1 and 55.6% respectively. Infection occurs at an early age; 7.9% of 1 to 4 yr olds had VSV-I antibody and 18.4%, VSV-N antibody. Prevalence increases smoothly with age, to plateau at 86% for VSV-I and 96% for VSV-N by age 30-49 yr. Both serotypes have been active in all 19 localities studied, although in varying degrees. The information obtained in this study has failed to shed new light on the mode of transmission of VSV but served to confirm the findings from earlier studies that these viruses are highly endemic in most rural areas of Panama (as well as other areas of Central America).

The prevalence ratios for males: females at ages 30 yrs. and above were between 2.7 and 10.7 for VEE, Mayaro and California viruses, indicating that infection was frequently acquired away from the home environment. The pattern was less striking for ILH and Punta Toro (ratios approx 2.0) and SLE (1.7). There was no significant difference between VSV male and females prevalences at any age. The antibody prevalence rates for Mayaro, Punta Toro

and both VSV viruses were higher in the Guaymi than in the non-indian population. Whether this is a reflection of behavioral differences or geographic distribution of the ethnic groups within the study area remains to be determined.

(P. Peralta, C. G. Hayes, A. Adames, C. Johnson, W.C. Reeves)

## II. SLE Viremia in Experimentally Infected Cormorants

Field studies have implicated the olivaceous cormorant (Phalacrocorax olivaceus) as an amplifying host of SLE virus in Panama. Three strains of SLE virus were isolated from this bird during widespread epizootic activity in 1973, and antibody positive rates as high as 23% were found during the 1977 epizootic in the Bayano River area. To further evaluate the role of the cormorant in the transmission cycle of SLE virus in Panama, we conducted viremia studies in the laboratory. Young cormorants captured from a breeding colony in Pacheca Island, Panama, during May, 1981, were returned to the laboratory and experimentally infected with SLE virus. All of the birds were screened for the presence of SLE antibody prior to inoculation and were found negative. To determine susceptibility, different groups of birds were inoculated with forty, 400; and 4000 PFU of a Panamanian strain of SLE virus, respectively. The cormorants were readily infected (5/6 birds) after receiving the lowest dose of virus, intramuscularly. The viremia response was delayed in the group receiving 40 PFU of virus, but the duration of viremia was not affected. The mean peak titer for the group receiving the most concentrated dose of virus was  $4.3 \log_{10}$  PFU/ml of blood; whereas, the mean peak titers for the groups inoculated with 400 and 40 PFU of virus were 3.1 and  $3.0 \log_{10}$  PFU/ml, respectively.

In another experiment, 3 different strains of SLE virus were inoculated into separate groups of cormorants (Table 2). Two of the virus strains were from Panama, and the other was a North American strain isolated from house sparrows during the 1975 epidemic. Both the Panamanian strains readily infected the cormorants, but differences were apparent. The cormorants isolated produced an average peak titer 42 times greater than the average peak titer for the mosquito isolate. The North American strain also readily infected the birds and produced peak titers intermediate to the two Panamanian isolates. The duration of viremia was similar for all three strains.

To confirm the ability of the cormorant to serve as a host for SLE virus, mosquitoes were fed on viremic birds.

Table 3 shows the susceptibility of Cx. p. quinquefasciatus, Hg. equinus and Ma. dyari. Greater than or equal to 50% of the Cx. p. quinquefasciatus females became infected after feeding on cormorants circulating 3.7 to 4.9 logs of SLE virus/ml of blood. Both Hg. equinus and Ma. dyari were considerably less susceptible than Cx. p. quinquefasciatus when fed on this host.

No mortality attributable to SLE virus infection was seen in any of the cormorants. Serological studies currently are in progress to quantify the antibody response of the birds.

The results of these experiments strongly support the field data that cormorants play an important role in the ecology of SLE virus in Panama.

(C. G. Hayes, B. Dutary, A. Adames, P. Galindo).

### III. Susceptibility of a Haemagogus equinus Cell Line to Yellow Fever Virus

A Haemagogus equinus cell line has been initiated from axenically hatched 1st instar larvae. The larvae were fragmented by passage through a 26-gauge needle attached to a 5 ml syringe or by gentle pressure with a small tenbroeck. The resulting fragments were suspended in Yunker's tick tissue culture medium containing 20% heat-inactivated fetal calf serum. The cell population consisted of a mixture of cells of different shape and size, but with increase in passage level there has been a tendency for epithelial-like cells to predominate. The cells are currently at passage level 12.

In order to evaluate the ability of the cells to support yellow fever virus replication, we infected a 25 cm<sup>2</sup> flask containing an almost confluent monolayer with  $7.2 \times 10^7$  PFU of YF virus, wild strain. Adsorption was carried out for 2 hours at 28°C, then the monolayer was rinsed twice before addition of maintenance medium (Yunker's + 5% heat-inactivated fetal calf serum). The culture was incubated at 28°C. The first fluid change was done on day 6 post-infection. Thereafter, fluid change has been done every 3-5 days.

Samples from supernatant fluid were collected at various intervals and stored at -70°C. Testing of these samples was done by plaque assay in Vero panels (Table 4). No cytopathic

effect has been observed in these mosquito cells. At present, the cells are on day 78 post-inoculation. Samples are still being collected for virus assay.

As part of the characterization of this cell line, we plan to test its susceptibility to a wide range of arboviruses.

(G. Oro)

Table 1. Neutralizing antibody in human population of Tabasara-Vigui River Basin, Panamá, 1981.

<u>Virus</u>	<u>ANTIBODY PREVALENCE</u> <u>ALL AGES</u>		<u>PREVALENCE RATIOS</u> <u>♂ ♂ (%) : ♀ ♀ (%)</u>	
	<u>No. Pos./</u> <u>No. Tested</u>	<u>% Pos.</u>	<u>All Ages</u>	<u>&gt;30 y.o.</u>
VEE	24/2980	0.81	1.4:0.3	3.9:1.0
SLE	83/2980	2.8	3.3:2.5	10.0:6.0
ILH	50/2980	1.7	2.0:1.3	8.1:4.1
MAY	12/734	1.6	2.6:1.2	10.7:1.0
GRO	15/734	2.0	1.8:2.1	6.7:8.9
CAL	16/734	2.0	3.2:1.0	8.0:3.0
PT	13/734	1.8	2.3:1.9	9.3:4.0
VSV-I	316/734	43.1	41.8:44.6	89.3:83.3
VSV-N	408/734	55.6	57.5:55.8	96.0:96.0

Table 2. Viremic response of Cormorants inoculated (im) with SLE virus strains from Panama and North America.

Virus strain*	Bird No.	Weight (gms)	Days post inoculation**						
			1	2	3	4	5	6	7
902604	401	890	1.3	3.8	4.3	2.3	+	-	-
	402	930	1.8	4.1	3.4	-	-	-	-
	403	966	2.4	3.4	3.5	-	-	-	-
	404	910	2.4	3.4	4.3	+	-	-	-
	405	533	-	3.5	4.7	4.4	+	+	dead
	406	851	+	3.1	4.1	+	-	-	-
Average peak titer = 4.2									
Mean duration = 4 days									
902613	407	965	-	-	2.1	1.8	+	-	-
	408	855	-	2.2	2.9	2.6	2.2	-	-
	409	823	-	1.3	2.5	2.5	1.3	-	-
	410	894	-	-	2.5	3.0	2.3	-	-
	411	849	-	2.7	2.7	1.9	+	-	-
	412	969	-	2.2	2.2	2.6	+	+	-
Average peak titer = 2.6									
Mean duration = 3.8 days									
MSI-7	413	793	+	3.1	2.8	-	-	-	-
	414	794	+	2.8	3.3	+	-	-	-
	415	960	+	2.8	3.0	-	-	-	-
	416	833	1.8	3.1	3.3	-	-	-	-
	417	856	+	3.1	3.9	+	+	-	-
	418	907	-	3.0	4.8	+	-	-	-
Average peak titer = 3.55									
Mean duration = 3.5 days									

\* 902604 = Cormorant isolate from Pacheca Island, Panama, 1973.

902613 = Haemagogus lucifer isolate from Bayano, Panama, 1973.

MSI-7 = House sparrow isolate from Mississippi, U.S.A., 1975.

\*\* Titers are expressed as Log<sub>10</sub> PFU/ml of blood.

+ = Virus detected by CPE in tubes but not by plaque assay in panels of Vero cells.

- + No virus detected

Table 3. Susceptibility of 3 species of Panamanian mosquitoes by feeding on viremic cormorants (Phalacrocorax olivaceus).

<u>Species</u>	<u>Titer</u>	<u>No.+ / Total</u>	<u>% +</u>
<u>Cx. P. quinquefasciatus</u>	3.7*	13/20	65.0
	4.4	6/12	50.0
	4.9	24/30	80.0
<u>Hg. equinus</u>	2.8-3.9	0/61	
	4.3	1/13	7.7
<u>Ma. dyari</u>	3.7-4.4	1/17	5.9

\*Log<sub>10</sub> PFU/ml of blood

Table 4. Growth of yellow fever virus, wild strain, in Hg. equinus cells.

<u>Day post-infection</u>	<u>Titer</u> <u>PFU/0.05 ml</u>
Inoculum	3.6 x 10 <sup>6</sup>
0*	9.5 x 10 <sup>0</sup>
1	0
2	1.3 x 10 <sup>4</sup>
3	5.6 x 10 <sup>4</sup>
6	1.5 x 10 <sup>4</sup>
8	3.6 x 10 <sup>3</sup>
10	2.6 x 10 <sup>2</sup>
13	1.7 x 10 <sup>3</sup>
17	1.2 x 10 <sup>1</sup>
22	2.2 x 10 <sup>1</sup>
27	1.9 x 10 <sup>2</sup>
35	1.8 x 10 <sup>3</sup>
42	6.0 x 10 <sup>3</sup>
43	1.2 x 10 <sup>4</sup>
44	7.0 x 10 <sup>3</sup>
45	2.7 x 10 <sup>3</sup>

\* Sample taken after the infected monolayer was rinsed twice and fresh medium added.

### Dengue in Puerto Rico

Epidemic dengue type 1 occurred in Puerto Rico during the summer and fall of 1978 as part of the pandemic which affected most of the Caribbean region between 1977 and 1980. During 1979, 1980 and the first months of 1981, dengue transmission was sporadic with only a few confirmed cases occurring each month. All viruses isolated during that time were dengue 1. Beginning in late July and early August, 1981, the number of reported cases of dengue-like illness began to increase and by early September, it was clear that an outbreak of dengue was in progress. It will be noted from the attached figure of reported dengue-like illness (Fig. 1) that the number of cases increased dramatically in September, peaked in October and began to decline in November 1981. By December, few cases were being reported. Approximately 70 paired sera per week were tested for dengue infection by HI with an average of 48% confirmation. Cases were reported from all over the island, but the area of highest transmission was the Southwest coast.

A total of 298 dengue viruses were isolated from patients with onset of illness between July 1 and December 31, 1981. Most (220) were identified by complement fixation and/or monoclonal antibody as dengue 1. The distribution of these isolates was islandwide, but, as might be expected, the majority were from the Southwest coast.

Dengue 4 was first isolated in Puerto Rico from a patient with onset in September, although serological evidence suggested it was on the island as early as August, 1981. Transmission of this serotype remained sporadic during October, increased in November, and by December was the dominant virus isolated in Puerto Rico (See Figure 2). During the first 2 months of 1982, reported dengue has been increasing again. Nearly 50% of cases have been from the San Juan metropolitan area and most of the new transmission appears to be dengue type 4.

(D. J. Gubler, G. Kuno, R. Novak, G. Sather, S. Waterman. Listed in alphabetical order)



Figure 1

# REPORTED DENGUE CASES BY DATE OF ONSET 1981 PUERTO RICO

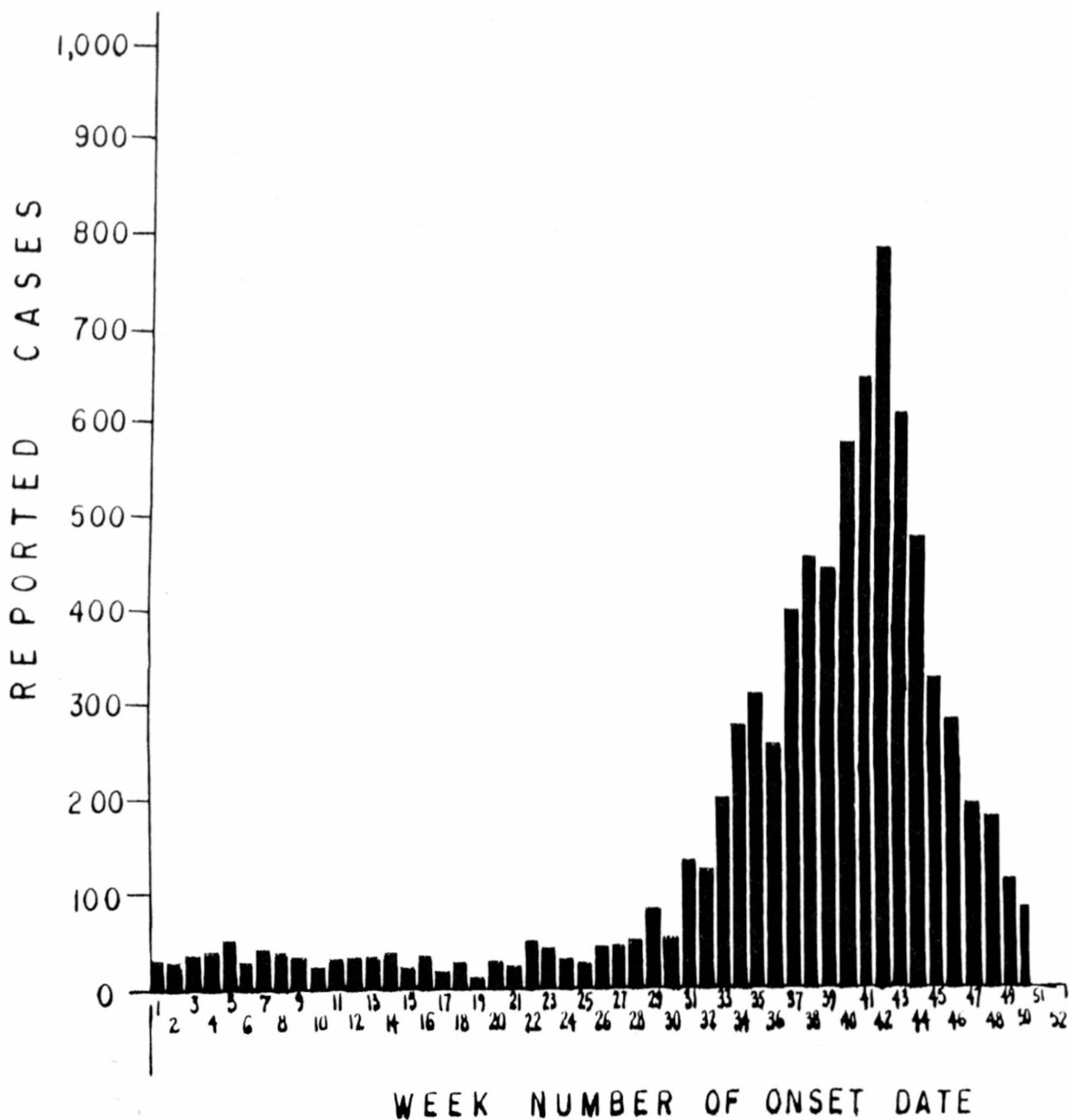
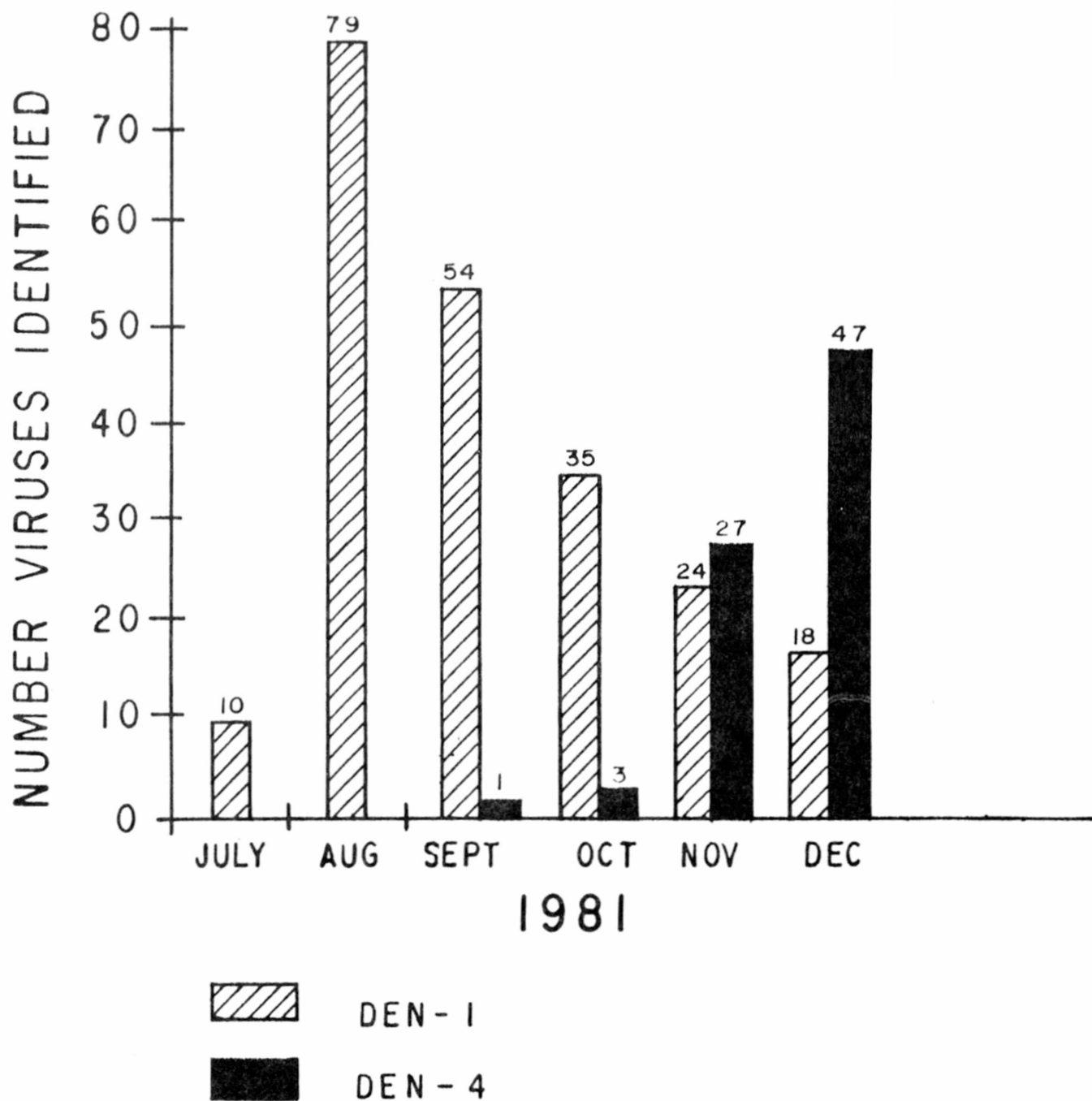


Figure 2

# VIRUSES ISOLATED AND IDENTIFIED PUERTO RICO JULY — DECEMBER 1981



## Comparative Sensitivity of Three Mosquito Cell Lines for the Isolation of Dengue Virus

The use of specific monoclonal antibodies has greatly facilitated the identification of dengue viruses. Although this technique can be used to identify dengue viral antigen in mosquito brain squashes, it requires a minimum of 6 and preferably 12 known positive mosquitoes. This means that most isolates must be passed in mosquitoes at least once after isolation and thus delays the identification process, whether by monoclonal antibody or complement fixation. Although less sensitive, the use of mosquito cell lines to isolate dengue viruses and the subsequent use of monoclonal antibodies to type the viruses is much less labor intensive and allows processing of larger numbers of samples.

These procedures were initiated during the dengue epidemic of 1981 in Puerto Rico. As a part of this transition, three mosquito cell lines, Igarashi's clone C6/36 of Aedes albopictus, Ae. pseudoscutellaris (AP-61), and Toxorhynchites amboinensis (TRA-284) were compared for sensitivity to dengue virus and ease of handling. Cells were grown in either disposable tubes (16 X 125 mm) or in plastic flasks (25 cm<sup>2</sup>) and simultaneously inoculated with 0.05 ml each of undiluted sera collected from patients in acute phase of dengue-like illness. After 10-day incubation at 28°C, the cells were spotted on slides, fixed with cold acetone, and processed for virus isolation and identification using a direct fluorescent antibody test (DFA) for screening and indirect (IFA) with monoclonal antibodies for identification.

The results obtained with 83 sera are shown in Table 1. The AP-61 and TRA-284 lines were most sensitive with 31 and 29 isolates respectively. Only 25 isolates were obtained with the C6/36 cells. It will be noted that some of the viruses isolated in C6/36 and AP-61 cells could not be typed. This was due to the small number of cells infected and the small amount of antigen detectable by DFA, but not by the monoclonal IFA. These sera have been inoculated into mosquitoes for confirmation.

In addition to virus isolation rate, the three cell lines were compared with respect to the following criteria: (1) ease of handling and cultivation; (2) brightness of fluorescence; (3) resistance to toxicity of sera; (4) growth rate in different types of culture vessels, and (5) cost/culture/specimen. While ease of cultivation was nearly the same for all three cell lines, A. albopictus cells were the best in terms of uniform dispersal of cells (without clumping) on spot slides. Intensity of fluorescence was similar for all cell lines, but easier to read in C6/36 because the cells were never disrupted. TRA-284 and AP-61 cells were generally more resistant to serum toxicity than A. albopictus cells. While both A. albopictus and AP-61 cells grew well on glass as well as plastic surface, TRA-284 cells did not grow well in glass tubes. The cost of tube culture was far less expensive than that of plastic culture. These advantages and disadvantages will be evaluated for the selection of a cell line for routine dengue virus isolation/identification.

(G. Kuno, D. J. Gubler, G. Sather)

Table 1

Comparative sensitivity of three mosquito cell lines  
for isolation of dengue viruses in Puerto Rico

Cell line	No. sera inoculated	Number and types of dengue isolates			
		D1	D4	Unknown	Total
C6/36	83	5	16	4	25
AP-61	83	8	21	2	31
TRA-284	83	9	20	0	29
Totals	83	9	26	2	37

(all cell lines)

REPORT FROM THE OFFICE OF LABORATORY SERVICES AND  
ENTOMOLOGY  
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES  
JACKSONVILLE, FLORIDA

Arbovirus surveillance in Florida for the period July through December 1981 was conducted in the same manner as the previous six months.

A total of 1877 patients' sera with CNS symptoms were tested by HI against EEE, VEE, SLE, Dengue and CAL antigens. There was only one laboratory confirmed SLE case in a 25 year old black male farm worker from South Central Florida. There were three confirmed and one presumptive cases of Dengue Type 4. The patients had visited Jamaica prior to onset. The two confirmed Dengue I cases had visited Puerto Rico prior to onset. No secondary cases were identified.

There was a total of 2365 chicken sera tested with 35 SLE and 3 EEE reactors. Most of the SLE activity was in central and west central counties.

As in the past, a mammal study was continued in the Tampa Bay area with 612 mammal sera tested for SLE and and EEE antibodies. There were 243 raccoon sera tested with ten SLE reactors (four of which seroconverted when recaptured). Of the 191 opossum sera examined, there were 13 SLE reactors (one of which seroconverted when recaptured, four also seroconverted to EEE). The remaining 178 mammal sera yielded eight SLE reactors; however, the time of infection could not be determined.

Culex nigripalpus populations were about average for the early summer, but in August heavy rains associated with hurricane Dennis resulted in very high counts in South Florida and the Tampa Bay area. The populations gradually decreased through September and by late October were at the usual level for that season. One hundred sixty-nine Culex nigripalpus mosquito pools from two Tampa Bay counties were processed for viral isolation. There were two SLE isolations, one from a pool of 60 mosquitoes trapped in Hillsborough County on August 28, 1981. The other SLE isolate came from a pool of 50 mosquitoes trapped in Pinellas County on September 22, 1981. This is the first time that SLE has been isolated from mosquitoes in the Tampa Bay area when no human cases were identified there.

E. C. Hartwig, F. M. Wellings, E. E. Buff, J. A. Mulrennan

KNOXVILLE, TENNESSEE

Cross-Priming of Cellular and Humoral Immune Responses to  
Alphavirus Infected Cells

The proposed mechanisms by which immunization with one alphavirus induces cross-protection against a heterologous alphavirus challenge are controversial and have included antibody-mediated as well as cell-mediated immune responses. Cross-reactive cytolytic T cells have been reported to be induced by one or two immunizations with a single alphavirus whereas the induction of cross-reacting antibody has required repeated (hyper) immunization. We have examined the kinetics and specificity of humoral and cellular immune responses to alphavirus antigens following in vivo immunization of C3H/HeJ mice with Sindbis virus. Sindbis-(Sin) immune mice were secondarily challenged 14 days later with the original immunizing Sin virus or with the heterologous alphavirus, Semliki Forest (SF).

One or two immunizations with Sin resulted in the appearance of a cross-reactive CTL response (figure 1, panel A) and a Sin-specific humoral response whether measured against viral antigens on infected cells (figure 2, panel A) or on virions (figure 3, panel A). However, when the heterologous SF virus was administered to Sin-immune mice, the resulting antibody response against Sin or SF-infected cells was greater than that observed following the homologous restimulation or the sham-SF stimulation (figure 2, panel B vs panel A and C, respectively). No enhancement of neutralizing activity against virions was observed after heterologous stimulation (figure 3, panel B vs A and C). Furthermore, the cross-reactive CTL response observed after heterologous virus challenge was enhanced at least two-fold above that observed after dual stimulation with Sindbis or sham-SF stimulation (figure 1, panel B vs panel A and C, respectively). The reciprocal immunization-challenge protocol yielded results in complete accordance with those reported above. The enhanced cross-reactive CTL response correlated with our previously reported time of cross-protection.

The results suggest that a single immunization with one alphavirus elicits a virus-specific humoral response and a cross-reactive T cell response while simultaneously cross-priming the immune system for a humoral response to the heterologous virus and an enhanced T cell response to either virus. Furthermore, it appeared that cross-priming could be detected only after heterologous virus challenge and only in assays which measured reactivity to viral antigens present on infected cells.

(J. A. Wolcott, C. J. Wust and A. Brown.)

## Figure Legends:

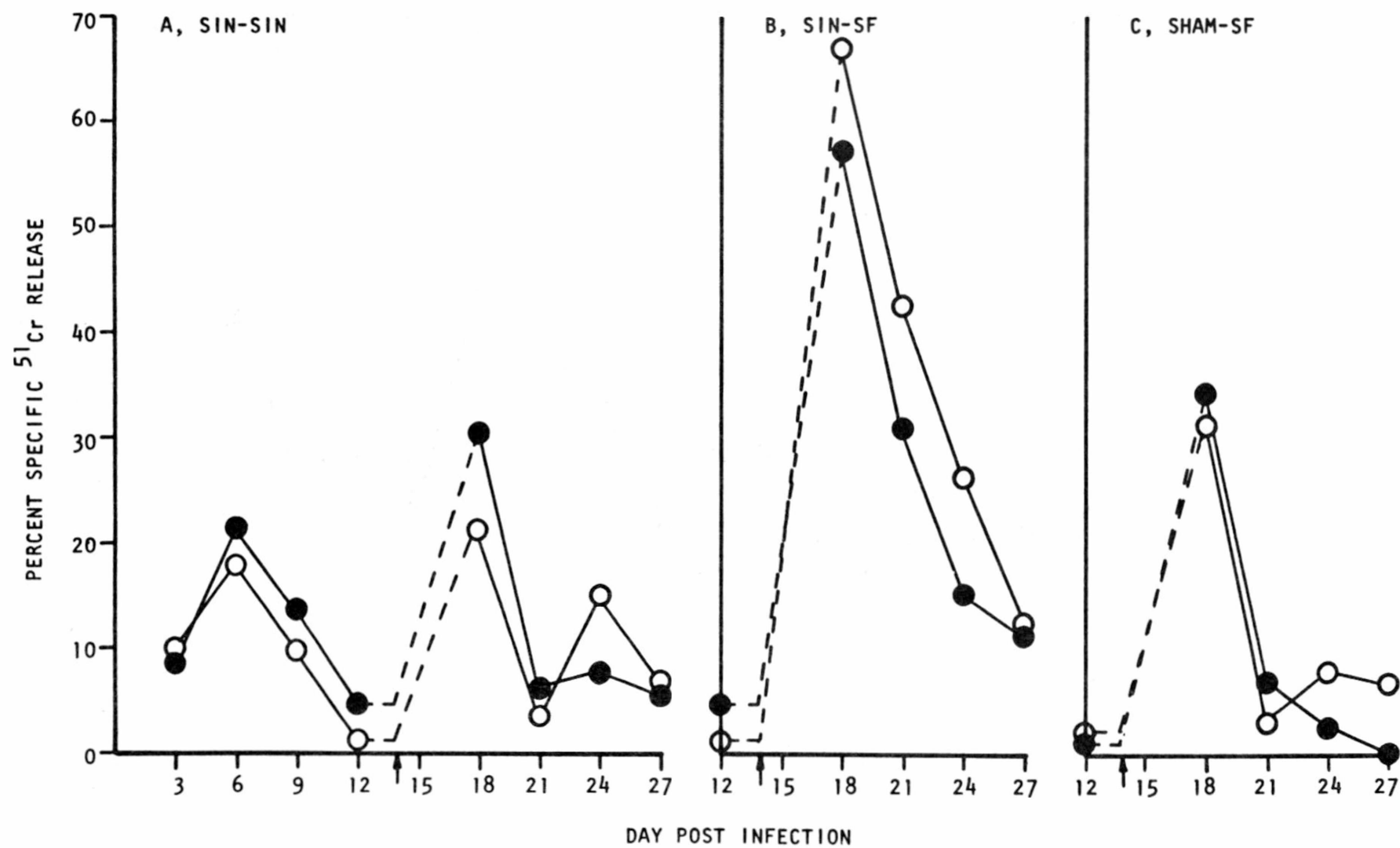
Mice were immunized with Sindbis (SIN) virus and restimulated 14 days later (↑) with SIN (panel A) or SF (panel B) or were sham-immunized and stimulated with SF (panel C).

Figure 1. At indicated intervals, 3-5 mice were killed, the spleen cells enriched for T-lymphocytes by passage over nylon wool and assayed for cytolytic activity on  $^{51}\text{Cr}$ -labeled L929 cells infected with SIN (●) or SF (○) virus. Uninfected cell lysis was <7%. Effector: Target ratio was 50:1.

Figure 2. At indicated intervals the sera from 3-5 mice were pooled, heat inactivated and assayed for cytolytic activity on  $^{51}\text{Cr}$ -labeled L929 cells infected with SIN (●) or SF (○) virus in the presence of exogenous rabbit complement. Uninfected cell lysis was <2%. Points represent maximal lysis at 1:20 or 1:40 dilution of antiserum.

Figure 3. Pooled sera from 3-5 mice were assayed for neutralizing activity against SIN (●) or SF (○) virus by 50% plaque reduction on CEF monolayers.

FIGURE 1





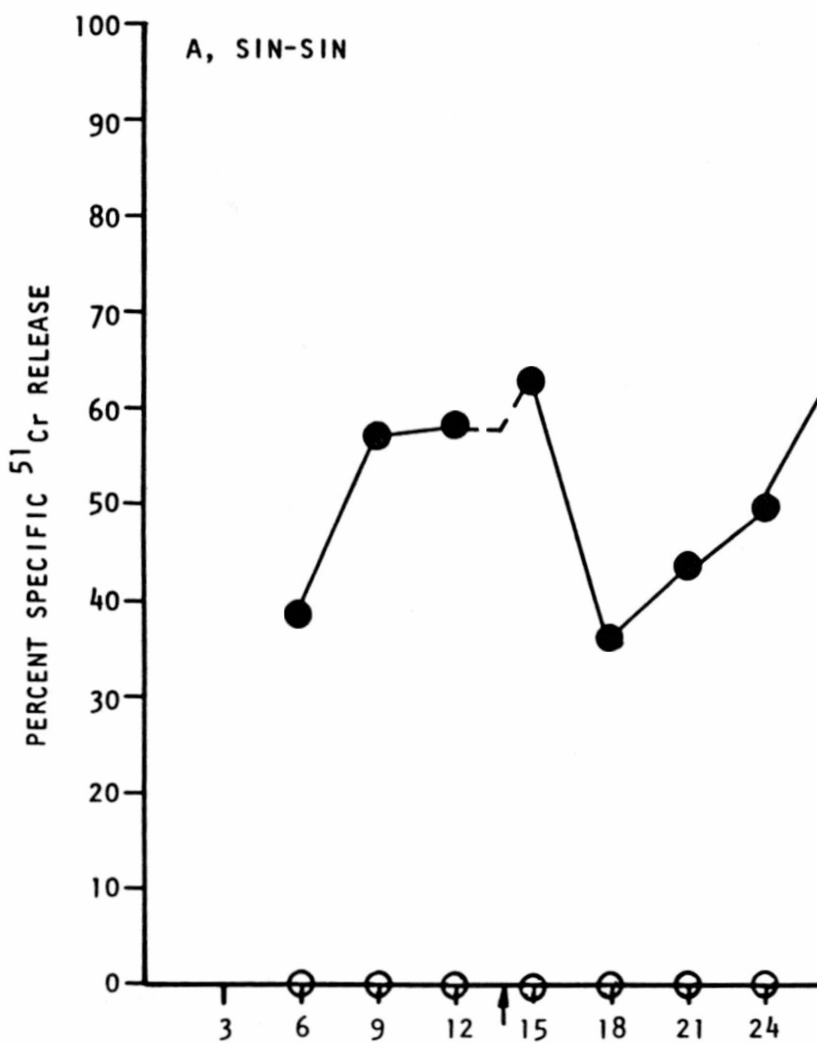
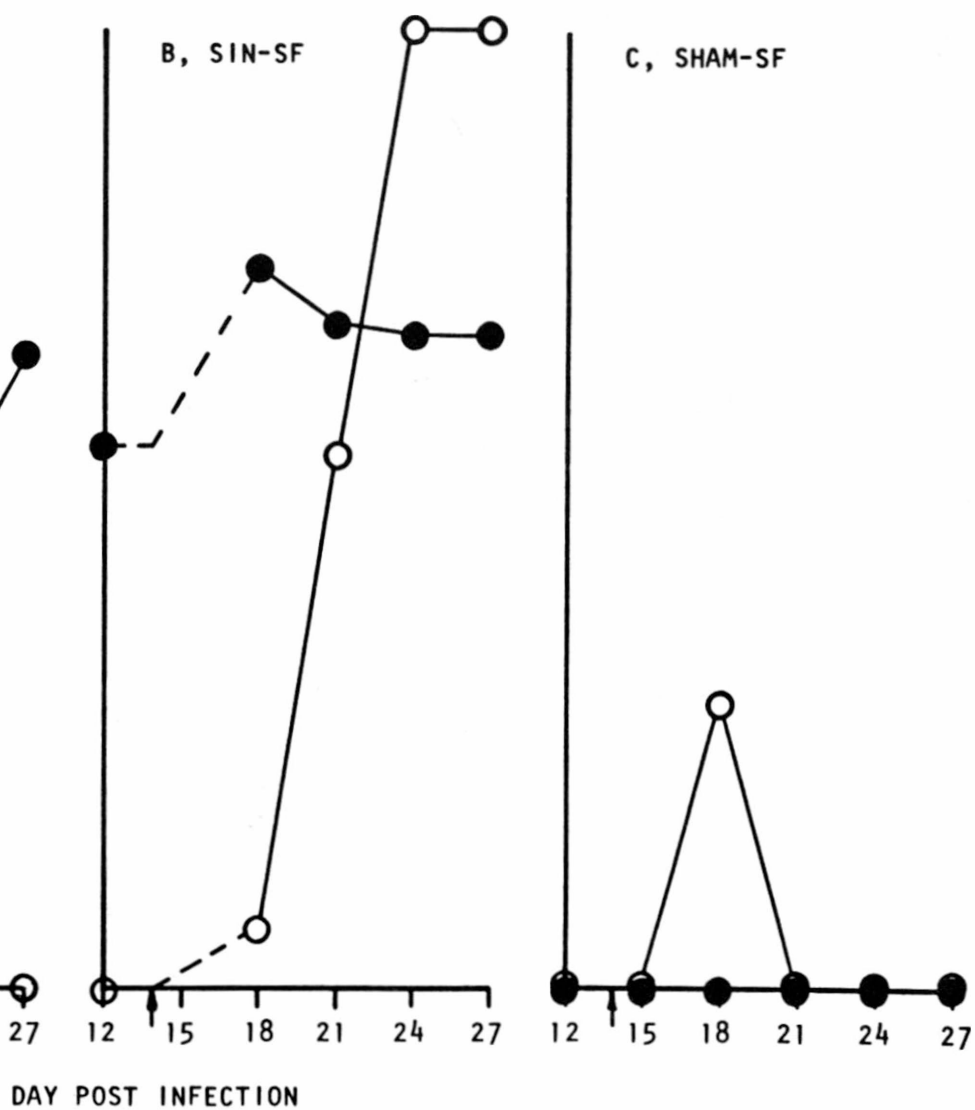


FIGURE 2



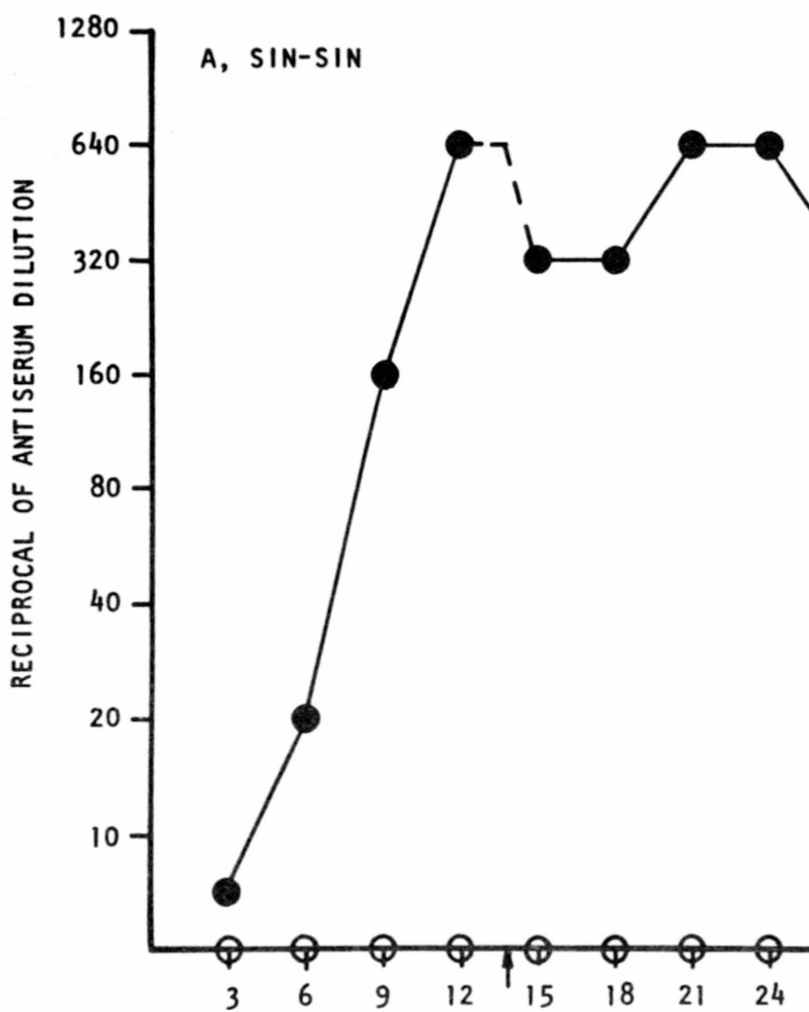
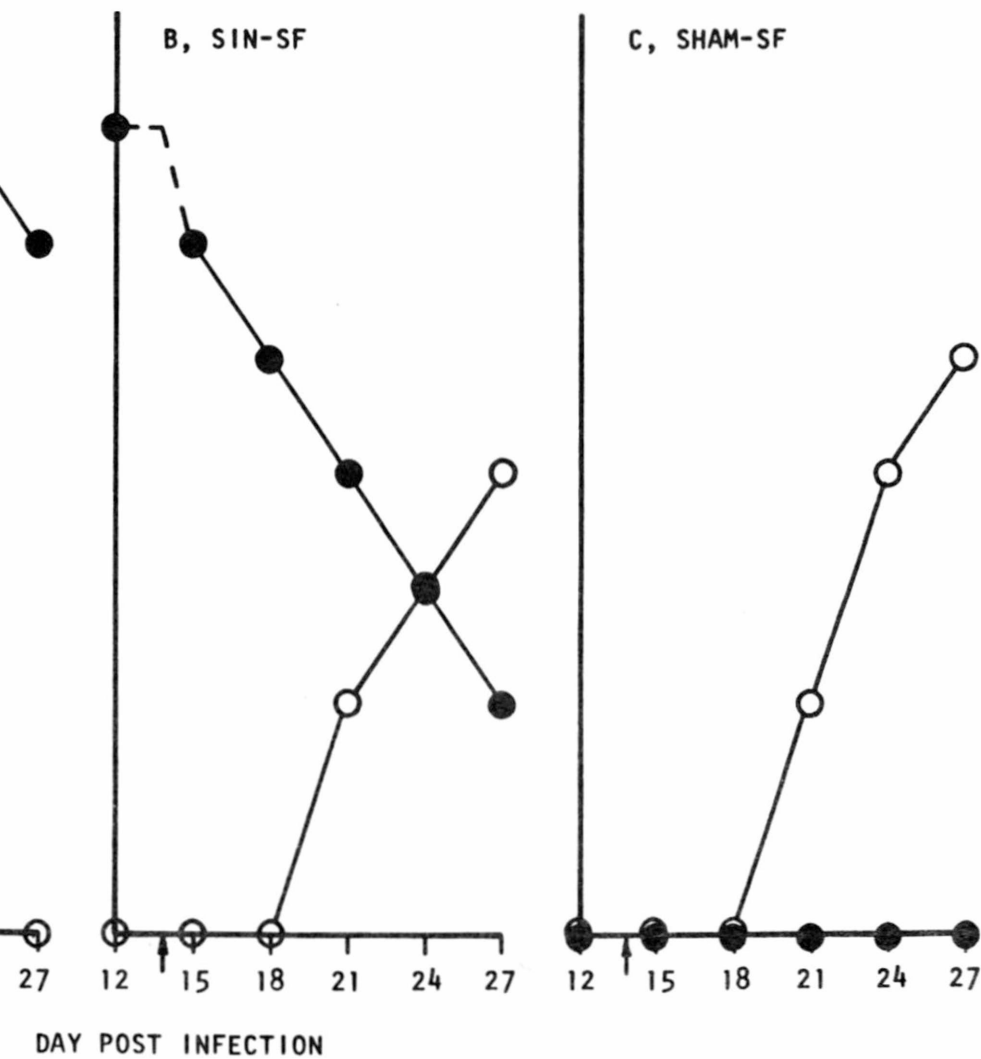


FIGURE 3



REPORT FROM THE NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES  
BETHESDA, MARYLAND 20205

The National Institute of Allergy and Infectious Diseases will soon have four new arbovirus reagents which will be available to domestic and foreign investigators upon request. The immune fluids have been prepared by the Plum Island Animal Disease Center, USDA, against African swine fever virus (ASF), African horsesickness virus (AHS), bovine ephemeral fever virus (BEF) and Rift Valley fever virus (RVF). The ASF reagent is an antiserum prepared in swine with titers of  $>1:10,000$  by ELISA. no CF antigen is available for testing but ASF reagent has no nonspecific CF titer at 1:4. Reagents for RVF, AHS, and BEF virus are immune ascitic fluids from mice and have titers as follows:

	HI	CF
RVF	80	16
AHS	Not done	32
BEF	Not done	$>512$

The above reagents will be packaged by American Type Culture Collection, Rockville, Maryland. Requestors should be aware that their use in domestic farm animals is prohibited in the United States. Inquiries concerning the availability of these and other arbovirus reagents may be directed to:

Sylvia Cunningham  
NIAID, NIH  
Westwood Building, Room 7A-03  
Bethesda, Maryland 20205  
Telephone: (301) 496-7036

Recently, NIAID awarded a contract to Yale University for the production of four additional sets of arboviral reference reagents. Reference virus and hyperimmune ascitic fluid will be prepared against Rocio, strain SPH-34675, R-10664, M-6846, CDC-SMI; St. Louis encephalitis, strain Parton; Venezuelan encephalitis, subtype I, variety D, strain 3880; and Venezuelan encephalitis, subtype I, variety E, strain Mena II. These reagents will not be available before October, 1982.

William P. Allen  
Sylvia Cunningham

THE DETECTION OF RIFT VALLEY FEVER VIRUS ANTIGEN BY ENZYME-  
LINKED IMMUNOSORBENT ASSAY (ELISA).

The recent Rift Valley fever (RVF) epidemic in Egypt has demonstrated the potential for this disease to extend its geographic boundaries and cause serious human and animal diseases. There are needs for rapid diagnostic tools to detect RVF in both humans and animals in known enzootic regions and potentially receptive extension zones. Since RVF antibodies may not be detectable during the first few days of disease and since the viremia often reaches high titers for several days, a viral antigen assay may be the method of choice in many circumstances.

A double antibody (sandwich) ELISA was adapted to detect RVF antigen. Antibodies against RVF virus were produced in rabbits and mice and purified by affinity chromatography using a BPL inactivated sucrose acetone extracted suckling mouse liver antigen coupled to CNBr activated Sepharose 4B (Pharmacia, Uppsala, Sweden).

Antigen was captured by mouse antibodies absorbed to the wells of polystyrene plate (Cooke M 29 AT, Dynatec Laboratories) and then detected by reacting sequentially with rabbit antibodies to RVF virus and swine-anti-rabbit IgG (Orion Diagnostica, Helsinki, Finland) conjugated to alkaline phosphatase.

The ELISA system was developed using supernatants from infected Vero cell cultures and had a sensitivity of just less than  $10^5$  pfu/ml. This ELISA could reliably detect  $5 \times 10^5$  pfu/ml of RVF virus in viremic hamster serum, a level of viremia often reached by infected domestic animals although hamsters mimic the progressive viremia seen in susceptible species such as lambs.

Rhesus monkey sera taken 48 hours after RVF infection were positive in ELISA even though viremias were only  $5 \times 10^2$  pfu/ml indicating the variation in the amount of antigen per plaque forming unit encountered in different circumstances.

The ELISA also proved useful in measuring viral antigen in vaccines and in infected mosquitos.

Several antigenically related Phleoviruses (Naples, Sicilian, Arumawat Punta Toro, Gordil, Karimabad) grown in cell cultures failed to react. This ELISA test for RVF antigens merits further considerations for field evaluation since it provides a rapid, specific, sensitive test which can detect viral antigen present in diagnostically relevant concentrations. Furthermore it can be prepared, standardized and performed entirely with inactivated reagents, increasing its utility in surveillance in nonendemic areas.

(Bo Niklasson, Monica Grandien, C.J. Peters and Thomas Gargan)

REPORT FROM THE DIVISION OF CLINICAL MICROBIOLOGY  
BUREAU OF LABORATORIES  
PENNSYLVANIA DEPARTMENT OF HEALTH  
LIONVILLE, PENNSYLVANIA

Arbovirus Surveillance in Pennsylvania, 1981

The Pennsylvania Departments of Health and Environmental Resources reinsti-  
tuted an arbovirus surveillance program similar to ones conducted during the  
summers of 1978 - 1980.

Sentinel flocks of four (4) chickens, mostly hens, were placed at 65 sites  
throughout the state at the locations shown in the Figure. This compares with  
68 sentinel sites in 1980. This year, there was at least 1 sentinel flock in 32  
of the 67 counties as compared with coverage in 36 counties in 1980. The chickens  
were bled weekly and the sera tested, after protamine sulfate-acetone extraction,  
for hemagglutination-inhibition (HI) antibodies against St. Louis Encephalitis  
(SLE), Western Equine Encephalitis (WEE), Eastern Equine Encephalitis (EEE), and  
California Encephalitis (CE) viruses. There were no seroconversions in 7976 HI  
tests performed through September 30, 1981. This was the second year in a row  
that the program in this format has revealed no arbovirus activity (Table).

Thirty-eight (38) serum samples from 29 patients with a clinical diagnosis  
of central nervous system disease were tested for serologic evidence of infection  
with SLE, WEE, EEE, and CE viruses. There was no evidence of infection with  
arboviruses in any of these cases.

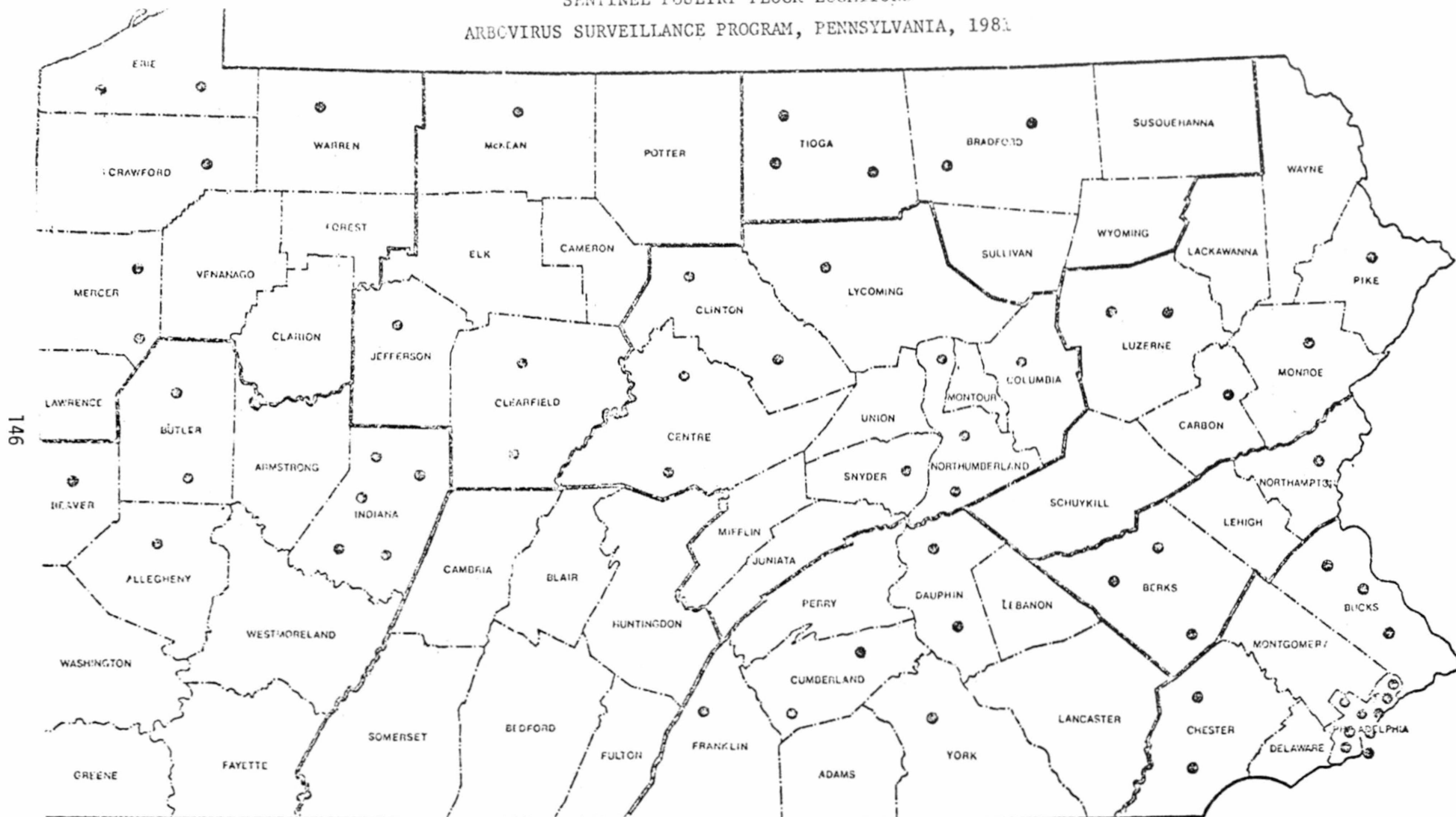
The surveillance program ended on September 30, 1981.

(Bruce Kleger, Vern Pidcoe, and Gisela Fischer)

TABLE  
RESULTS OF HEMAGGLUTINATION-INHIBITION (HI) TESTING  
ARBOVIRUS SURVEILLANCE PROGRAM  
PENNSYLVANIA, 1978-1981

<u>Year</u>	<u>No. of serum samples tested</u>	<u>No. with HI antibodies against</u>			
		<u>WEE</u>	<u>SLE</u>	<u>EEE</u>	<u>CEV</u>
1978	2493	1	0	0	0
1979	2364	3	1	0	0
1980	2795	0	0	0	0
1981	2225	0	0	0	0

SENTINEL POULTRY FLOCK LOCATIONS  
ARBOVIRUS SURVEILLANCE PROGRAM, PENNSYLVANIA, 1981





REPORT FROM THE VIROLOGY PROGRAM, STATE OF NEW JERSEY DEPARTMENT OF HEALTH,  
TRENTON, NEW JERSEY

Arbovirus Surveillance in New Jersey, 1981

During the 1981 surveillance period, from May through November, 2048 mosquito pools containing up to 125 mosquitoes each, were received and tested. There were sixty (60) mosquito pools positive for Eastern equine encephalitis (EEE) while Western equine encephalitis (WEE) was isolated from fifty-two (52).

Table I summarizes the collection area totals, species of mosquito and time of collection for the EEE isolates. Activity began with mid-July collections and continued through October. There were forty-nine (49) isolates from Culiseta melanura pools at five (5) sites; ten (10) isolates from Anopheles quadrimaculatus pools at two (2) sites; and a single Culex salinarius pool.

WEE activity is summarized in Table II. The July collections yielded the first isolates with continued observation of WEE activity into October. There were fifty (50) isolates from Culiseta melanura pools at seven (7) collection sites; and one (1) each of Culex restuans and Culex salinarius.

Sentinel chicken flocks of ten (10) cockerals were placed at twelve (12) sites throughout the State in June. The flocks were bled weekly on a rotating schedule through October and St. Louis encephalitis neutralization tests were conducted in mice. There were no conversions observed in the 700 sera collected.

(David Kirsh, Bernard Taylor and Wayne Pizzuti)

TABLE I

		1981 EE MOSQUITO POOL ISOLATES FOR WEEK ENDING																	AREA TOTALS
AREA COLLECTED	MOSQUITO SPECIES	7/11	7/24	7/31	8/7	8/14	8/21	8/28	9/4	9/11	9/18	9/25	10/2	10/9	10/16	10/23	10/30		
Burlington Co.	Cs. melanura									1		1						2	
Dennisville	Cs. melanura		1			1		3	5	2	2				1			15	
"	An. quadri- maculatus								1						1			2	
Green Bank	Cs. melanura											1		1				2	
New Gretna	Cs. melanura														1			1	
Woodbine	Cs. melanura	1	1		1	2	1	2	3	5	3	2	4	1	1	1	1	29	
"	An. quadri- maculatus					1		1	2	1		1		1		1		8	
"	C. salinarius									1								1	
WEEKLY TOTALS		1	2	0	1	4	1	6	11	10	5	5	4	3	4	2	1	60	

TABLE II

AREA COLLECTED	MOSQUITO SPECIES	1981 WE MOSQUITO POOL ISOLATES FOR WEEK ENDING																		AREA TOTALS
		7 / 3	7/ 10	7/ 17	7/ 24	7/ 31	8 / 7	8 / 14	8/ 21	8/ 28	9 / 4	9 / 11	9 / 18	9 / 25	10 / 2	10 / 9	10 / 16	10 / 23	10 / 30	
Bass River	Cs. melanura							2			1					1				4
Burlington Co.	Cs. melanura											1								1
Dennisville	Cs. melanura		1				3		1	1	1	1	1	1	1					12
Green Bank	Cs. melanura	1	1		2	2	1	1			2	1	2	1						14
" "	C. restuans			1																1
New Gretna	Cs. melanura						1	2		2	1	1			1					8
Vincentown	Cs. melanura										1									1
Woodbine	Cs. melanura		1			1			2		1		2		1	1			1	10
"	C. salinarius		1																	1
WEEKLY TOTALS		1	4	1	2	3	5	5	3	3	7	3	6	2	3	3	0	0	1	52

REPORT FROM THE STATE OF NEW YORK DEPARTMENT OF HEALTH  
CENTER FOR LABORATORIES AND RESEARCH, ALBANY, NEW YORK

During the summer of 1981, serum samples from 293 patients with signs of central nervous system infection or with fever of unknown origin were tested for hemagglutination inhibiting antibodies to EEE, WEE, SLE, POW and CE viruses. Neutralization tests were also performed with these sera using one of the New York State LaCrosse-like isolates (74-32813) of CE virus. Serologic evidence of current CE virus infection was obtained in 5 patients and a presumptive diagnosis of CE infection was made in an additional 13 patients whose sera reacted by HI and showed high levels of neutralizing antibody ( $NI \geq 3$ ) to CE virus. Most of these patients resided in the eastern region of New York State in counties of the middle and lower Hudson Valley: Columbia (2), Ulster (4), Dutchess (1), Westchester (3). Most cases occurred from June to September, however, one of the patients with serum conversion had an onset in October. Only 2 of the patients were children or adolescents, while most of them were adults between 21 and 39 years of age. This is consistent with the change in age distribution first observed in 1978; before this time the majority of patients with CE infections were children.

In collaboration with the Bureau of Disease Control, mosquitoes were collected in four regions: Buffalo, Syracuse, Albany, White Plains, and tested for viruses in Vero cell cultures. Nineteen isolates of California encephalitis complex (CAL) were obtained from 1,753 pools of 163,301 mosquitoes collected from May to September 1981. No other viruses were isolated. More than half of the CAL isolates were from the Albany region where viruses were isolated mostly from Aedes communis. A high minimum field rate was also found in Aedes sollicitans collected in Suffolk County of the White Plains region (Table 1).

RNase T<sub>1</sub> fingerprint data confirmed and extended the observation of El Said et al. (Am. J. Trop. Med. Hyg. 28, 364-368, 1979) that isolates of LaCrosse virus (LAC) from the region around Albany, New York are substantially different from prototype LAC virus at the genomic level. Monoclonal antibodies were produced by hybridomas isolated after fusing the spleen cells from a mouse immunized with prototype LaCrosse virus with myeloma cells. They were tested in an ELISA which employed purified virus as the antigen in the solid phase. Viral antigens were adjusted to contain the same amount of total viral protein in each assay. The results are expressed in terms of the intensity of color development. These experiments showed that New York isolates of LAC can be distinguished antigenically from the prototype strain and also that all of the LAC isolates so far examined can be differentiated from the closely related Snowshoe Hare virus as illustrated in Table 2.

(Sunthorn Srihongse, Margaret A. Grayson, Leo J. Grady and Rudolf Deibel)

Laboratories for Virology  
Center for Laboratories and Research  
New York State Department of Health  
Albany, New York 12201

Table 1  
Arbovirus Surveillance, 1981  
Wild-Caught Mosquitoes

	No. Tested		No. CAL Isolates	
	Pools	Specimens		
<u>Region:</u>				
Buffalo	605 (428)*	48,307 (44,171)*	5	
Syracuse	339 (31)	53,639 (5,649)	0	
Albany	533 (409)	28,584 (23,160)	10	
White Plains	276 (164)	32,771 (18,677)	4	
Total	1,753 (1,032)	163,301 (91,647)	19	
<u>Genus and Species:</u>				<u>Minimum field infection rate:</u>
<u>Aedes aurifer</u>	4	210		
<u>Aedes cantator</u>	66	8,056		
<u>Aedes canadensis</u>	90	7,995	1	1:7,995
<u>Aedes cinereus</u>	12	1,244		
<u>Aedes communis</u>	149	16,387	7	1:2,341
<u>Aedes dorsalis</u>	7	77		
<u>Aedes excrucians</u>	4	97		
<u>Aedes sollicitans</u>	68	7,688	4	1:1,922
<u>Aedes stimulans</u>	154	15,217	3	1:5,072
<u>Aedes triseriatus</u>	39	2,027		
<u>Aedes trivittatus</u>	49	2,558		
<u>Aedes vexans</u>	131	20,209		
Mixed <u>Aedes</u> spp.	181	5,785	3	1:1,928
Other <u>Aedes</u> spp.	78	4,097	1	1:4,097
<u>Culex</u> spp.	191	15,419		
<u>Culiseta</u> spp.	291	42,582		
<u>Coquillettidia</u> spp.	138	12,277		
<u>Anopheles</u> spp.	95	1,360		
Other mosquitoes	6	16		
Total	1,753	163,301	19	

\*( ) Aedes spp.

Laboratories for Virology  
Center for Laboratories and Research  
New York State Department of Health  
Albany, New York 12201

Table 2

ELISA Results of LAC Monoclonal Antibodies

Monoclonal Antibodies	Viruses					
	LaCrosse (LAC)			Snowshoe Hare (SSH)		Trivittatus (TVT)
	Prototype	N.Y. 76-33795	N.Y. 74-32813	Prototype	N.Y. 65-8569	Prototype
2 B 9	+++	+++	+++	+++	+++	+
1 A 7	+++	+++	+++	+++	+++	0
5 D 4	+++	+++	+++	+++	+++	0
1 E 6	+++	+++	+++	+++	+++	0
7 B 11	+++	+++	+++	±	±	0
5 D 2	+++	+++	+++	0	0	0
3 G 8	+++	0	0	0	0	0

Infection and transmission intestinal threshold experiments with Guatemalan Cu. (Mel.) taeniopus (formerly opisthopus), a proven vector mosquito of VE virus in Guatemala, have shown that this mosquito is infected by small oral doses of enzootic strains of VE virus from Middle America. In contrast, the mosquito is highly resistant to epizootic strains that appeared during the 1969-1971 epidemic-equine epizootic in Middle America. This resistance of vector Cu. (Mel.) taeniopus was probably a factor in the apparent disappearance of an epizootic VE strain from a marsh focus of enzootic VE virus on the Pacific coast of Guatemala subsequent to the 1969 outbreak.

Precipitin tests of bloodmeals found in mosquitoes collected in Guatemala suggest strongly that Cu. (Mel.) taeniopus females are opportunistic in their feeding habits.

Sentinel hamsters continued to show activity of VE, Nepuyo group C and group Patois viruses during 1980 at a Pacific coastal enzootic marsh habitat in Guatemala. Sentinel guinea pigs at this habitat developed VE HI antibody, but did not die. At an Atlantic coastal enzootic habitat of VE virus, some sentinel English shorthair guinea pigs died, but the VE viruses recovered from their tissues were not lethal for other guinea pigs upon passage, and thus were like enzootic rather than epizootic VE virus strains. Possibly dehydration caused the deaths of the five guinea pigs at this site.

Toxorhynchites amboinensis inoculated intrathoracically were compared with suckling mice inoculated intracranially for quantitation of infectious group C, Nepuyo, and group Patois, Patois, bunyaviruses. In neither case were titration endpoints in T. amboinensis much different than in suckling mice; ID<sub>50</sub>/ml in T. amboinensis were approximately the same or only 1.5 log<sub>10</sub> higher than LD<sub>50</sub>/ml in suckling mice.

VE isolates from Brazil and French Guyana were studied by hydroxylapatite chromatography and for virulences for English shorthair guinea pigs and Syrian hamsters. Ten isolates displayed a spectrum within the VE complex that seemed to vary within itself, but indicated that these strains are different from VE isolates from other regions of South America, Middle America and Florida, U.S.A.

An Ecuadorian strain of VE virus (R16905) from the Center for Disease Control at Fort Collins was clearly in subtype I-AB by HI tests using rooster plasmas. It had an hydroxylapatite elution profile and pH of hemagglutination pattern typical of subtype I-AB VE virus.

VE virus, Mexican enzootic subtype I-E strain 63U2, retained essentially equal infectivity titers in frozen avian blood stored more than 12 years at -60 C whether the blood contained heparin at 20 units/ml or no heparin. Evidently concentrations of heparin used in the field to prevent coagulation of avian blood (usually less than 20 units/ml) did not inactivate VE virus during prolonged storage at -60 C.

(W.F. Scherer, R.W. Dickerman (NY) and E.W. Cupp (Ithaca))

# REPORT FROM THE YALE ARBOVIRUS RESEARCH UNIT

Department of Epidemiology and Public Health, 60 College Street, P.O. Box 3333, New Haven, Ct. 06510

Enzyme immunoassay (EIA) techniques have been developed for surveillance of arboviruses in vector populations and for diagnosis of arbovirus infections in man. For surveillance, an antigen-detecting EIA has been developed to detect infected mosquitoes in pools of noninfected mosquitoes. For diagnosis, a capture-IgM EIA has been developed to detect specific, early-appearing IgM in serum and CSF.

## EIA for Arbovirus Surveillance

An EIA, producing either a chromogenic (EIA-C) or a fluorogenic (EIA-F) reaction, was developed and evaluated for detecting La Crosse (LAC) virus antigen in mosquito pools.

The solid-phase EIA procedures were patterned after those of Yolken (Yale J. Biol. and Med. 53:85-92, 1980). Mouse anti-LAC IgG was coated to the surface of 96 well Micro-Elisa plates (Dynatech) using a carbonate-bicarbonate buffer. After washing with PBS-tween, mosquito suspensions (in a diluent consisting of 0.02M PBS with 0.1% tween-20 and 1.0% heat inactivated fetal bovine serum) were added to the wells and were incubated one hour at 37C. After washing, a detector antibody (rabbit anti-LAC) system was added. Plates were incubated for one hour at 37C and washed. The conjugate, goat IgG anti-rabbit IgG linked with alkaline phosphatase, was added and incubated for one hour at 37C. After conjugate removal, plates were thoroughly washed, and the substrate was added. For the EIA-C, p-nitrophenyl phosphate (1 mg/ml in diethanolamine buffer) was added and plates were read spectrophotometrically using a TireTek Multiskan plate reader or scored visually. For the EIA-F, the fluorogenic substrate, 4-methyl umbelliferyl phosphate (0.025 mg/ml of diethanolamine buffer was added and plates were scored qualitatively using a Blakray transilluminator (Ultra-Violet Products).

The sensitivity of the EIA was investigated by incorporating infected mosquitoes with various numbers of noninfected mosquitoes (Table 1). The EIA was easily capable of detection of one infected mosquito in a pool of 99 noninfected. The mean absorbance value (0.413) was much greater than 3 standard deviations above the control negative pool. Thus the limits of sensitivity of the test have not been approached. The specificity of the EIA was also acceptable (Table 2). Only closely related California group viruses cross-reacted; there was no detectable cross-reaction with viruses from other families.

Antigen remained stable through seven freeze-thaw cycles (Table 3). Thus even if virus infectivity had been lost as a consequence of thawing or repeated assay procedures, antigen could still be detected by the system.

These studies demonstrate that EIA may be a suitable technique for surveillance of bunyaviruses in infected arthropod pools. Since virus antigen is not only detected but also specifically identified, diagnosis can be obtained within five hours after receipt of specimens. The same system works for detection of alphavirus antigens. However, for detection of EEE and Highlands J

virus antigens, incubation times in the EIA must be lengthened.

#### EIA for IgM Detection

A capture-IgM EIA has been developed to detect early-appearing specific IgM in serum and CSF of patients with LaCrosse virus infections.

For the solid-phase of the EIA, sheep anti-human IgM antibodies were coated to 96-well ELISA plates using carbonate buffer. Coated plates were subsequently incubated for one hour at 37C with 0.05M n-acetyl-cysteine as a "blocking" step. Serum samples were diluted 1:100 in PBS-gelatin (0.05%)-tween (0.1%)-fetal bovine serum (0.5%) and added to the wells. After two hours incubation at 37C, plates were washed and, for each patient, purified LAC antigen was added to four wells and negative antigen (prepared from noninfected BHK-21 cells) was added to two wells. Plates were incubated one hour at 37C and then washed. Subsequent mouse anti-LAC antibodies conjugated with alkaline phosphatase were added and the plates were incubated for one hour at 37C. Unbound conjugate was removed and p-nitrophenyl phosphate was added. Absorbances were read using a TiterTek Multiskan (Dynatech).

The capture IgM system was examined for the following characteristics: 1) IgM specificity: Sequential dilutions of anti-IgM antibodies were added to both high and low IgM positive samples as determined by indirect immunofluorescence (IFA). Absorbance values were greatly decreased by removal of IgM from the system. 2) LAC virus specificity: Absorbance values were significantly reduced by incubation of positive serums with a LAC virus antigen suspension. 3) Effect of rheumatoid factor: Rf-positive samples were constructed and compared with similarly constructed Rf-negative samples. Interestingly, addition of Rf to samples (which were then positive in latex agglutination tests) seemed to reduce absorbance values of specimens.

Once the specificity of the system had been demonstrated, 29 acute phase serum samples from patients subsequently diagnosed as having had LAC virus infections were examined for the presence of IgM. Results were compared with those obtained with the IFA procedure. Results are shown in Table 4. The EIA seemed to be much more sensitive than IFA for detection of IgM antibody.

Preliminary results with IgM detection in CSF are most encouraging. The capture IgM system is much more sensitive than IFA, and background due to nonspecific protein binding common in serum samples is nonexistent with CSF.

Thus the capture-IgM EIA seems to be a very suitable technique for clinically-relevant diagnosis of LAC virus infections.

(B. Beaty, S. Hildreth, and T. Jamnback)



Table 1. Detection of La Crosse viral antigen in mosquito pools containing infected individual mosquitoes<sup>a</sup>

Mosquito Pools		EIA ( -C and -F) Results <sup>b</sup>			
composition of pool (+,-)	total in pool	Substrate = NPP mean absorbance	Substrate = NPP qualitative score	Substrate=MUP qualitative score	virus isolation <sup>c</sup>
1+, 0-	1	0.420	+2	+3	+
1+, 9-	10	0.405	+2	+3	+
1+, 49-	50	0.392	+2	+3	+
1+, 99-	100	0.413	+2	+3	+
3+, 0-	3	0.947	+3	+4	+
3+, 7-	10	0.941	+3	+4	+
3+, 47-	50	0.869	+3	+4	NT
3+, 97-	100	0.985	+3	+4	+
0+, 0-	0	0.065	-	-	-
0+, 3-	3	0.097	-	-	-
0+, 10-	10	0.078	-	-	-
0+, 50-	50	0.088	-	-	-
0+, 100-	100	0.090	-	-	-
LAC virus tissue culture fluid, positive control.		0.445	+2	+3	+

<sup>a</sup>All pools tested at 1:10 dilution and positive control at 1:100 dilution. EIA systems consisted of a visual enzymatic product (EIA-C) from the substrate p-nitrophenyl phosphate (NPP) and a fluorogenic enzymatic product (EIA-F) from the substrate 4-methyl umbelliferyl phosphate (MUP).

<sup>b</sup>All EIA results are an average of three tests; absorbances are expressed as geometric means and qualitative scoring ranges from - to +4.

<sup>c</sup>Virus isolation performed with BHK-21 cells. NT=Not Tested.

Table 2. Specificity of La Crosse viral antigen detecting EIA systems<sup>a</sup>

Mosquito Pools		EIA (-C and -F) Results		
Virus	Composition of pools (+,-)	Substrate = NPP		Substrate=MUP
		Mean Absorbance	Qualitative Score	Qualitative Score
Control	0+, 3-	0.047	-	-
LAC	3+, 0-	0.812	+3 - +4	+4
SSH	3+, 0-	0.429	+2 - +3	+1-+2
JC	3+, 0-	0.176	+1	+/-
KEY	3+, 0-	0.093	-	-
TVT	3+, 0-	0.054	-	-
WEE	3+, 0-	0.050	-	-
DEN	3+, 0-	0.055	-	-
FLA	3+, 0-	0.043	-	-
LAC virus tissue culture fluid as positive control		0.728	+3	+4
Sample diluent as negative control		0.047	-	-

<sup>a</sup>Same footnotes as a and b of Table 2.

Table 3. Effect of freezing and thawing in the detection of La Crosse viral antigen within mosquito pools<sup>a</sup>.

Freeze and thaw <sup>b</sup> (F-T) cycle (no.)	Mean adsorbance values from EIA by pool and freeze-thaw (F-T) cycle <sup>c</sup> .		
	Pool 1	Pool 2	Pool 3
F-T (2)	0.599 (.545-.658)	0.476 (.458-.496)	0.549 (.527-.572)
F-T (3)	0.559 (.521-.598)	0.461 (.395-.539)	0.579 (.515-.649)
F-T (4)	0.750 (.608-.925)	0.454 (.422-.488)	0.544 (.454-.529)
F-T (5)	0.690 (.645-.739)	0.416 (.396-.436)	0.490 (.454-.529)
F-T (6)	0.700 (.646-.759)	0.430 (.409-.452)	0.590 (.478-.543)
F-T (7)	0.528 (.496-.561)	0.502 (.468-.539)	0.479 (.454-.504)

<sup>a</sup> Absorbance values given as geometric mean (95% confidence interval) of three tests. All samples were qualitatively scored +3 with the EIA-C; the EIA-F was not done.

<sup>b</sup> F-T (1) of mosquito tissues occurs during the procedure of collection, identification, and storage (-70°C), and subsequent triturating of pools.

<sup>c</sup> The geometric means of absorbance values for the F-T cycles were significantly different for pool-1 ( $F_{5,12}=6.23$ ,  $p=.0045$ ) and pool-3 ( $F_{5,12}=3.66$ ,  $p=.0305$ ), although only border-line significant for pool-2 ( $F_{5,12}=2.70$ ,  $p=.0737$ ).

Table 4

Detection of IgM in acute phase serum samples of patients  
with LAC virus infections

IFA	EIA		
	+	-	
+	16	0	16
-	8	5	13
	24	5	29

REPORT FROM THE ARBOVIRUS SURVEILLANCE PROGRAM, DIVISION OF  
LABORATORIES, ILLINOIS DEPARTMENT OF PUBLIC HEALTH, CHICAGO,  
ILLINOIS 60612

During the 1981 arbovirus season, 4,485 birds were bled and tested for HI antibodies to SLE, WEE, and EEE viruses. In this sample, taken from May through September, 0.8 percent (8 of 1058) of the adults and 0.6 percent (19 of 3427) of the juvenile birds were positive (i.e. titers of 1:20 or greater). All positive birds were house sparrows (Passer domesticus). Birds were collected in the same nine counties that we have repetitively surveyed since 1976. Following the upswing in 1980, this (0.6%) marked a down turn in the percent of juvenile birds with HI antibodies to SLE virus (Fig. 1). No human SLE cases were detected by laboratory testing this year following the occurrence of four cases in 1980 after 2 years without reported cases. The trend in - number of human SLE cases corresponds very closely with the percentage of positive juvenile birds observed from 1976-1981.

As expected, human arboviral encephalitis caused by a California group virus (probably LaCrosse) was diagnosed and confirmed in seven Illinois children. This group included four boys and three girls - ages 3 to 12 years. Onset of illness ranged from July 21 to September 25. Although the geographic distribution was fairly typical for Illinois cases (Fig. 2) the 3 year-old boy from Jersey County was one of the southernmost ever noted in the state. Several strains of LaCrosse virus were isolated from our Peoria County study area.

A third arbovirus was actively transmitted in Illinois during 1981. That virus, WEE, produced antibodies in juvenile house sparrows in St. Clair and Cook Counties. We have seen this type of activity during the last several years. However, for the first time since 1978, when we began a cooperative equine encephalitis serosurveillance program with the Illinois Department of Agriculture, nine cases of WEE were confirmed (Fig. 2). Two of these were fatal. We have no complete explanation for the apparent resurgence of WEE activity this year. However, staff at the Macon Mosquito Abatement District in Decatur reported an increase in the abundance of Culex tarsalis mosquitoes in central Illinois. This species is the principal WEE vector in western United States. WEE has never been isolated from mosquitoes in Illinois and

only once from a source other than equine brain tissue. In 1977, WEE virus was isolated from the blood of a nestling house sparrow in Christian County.

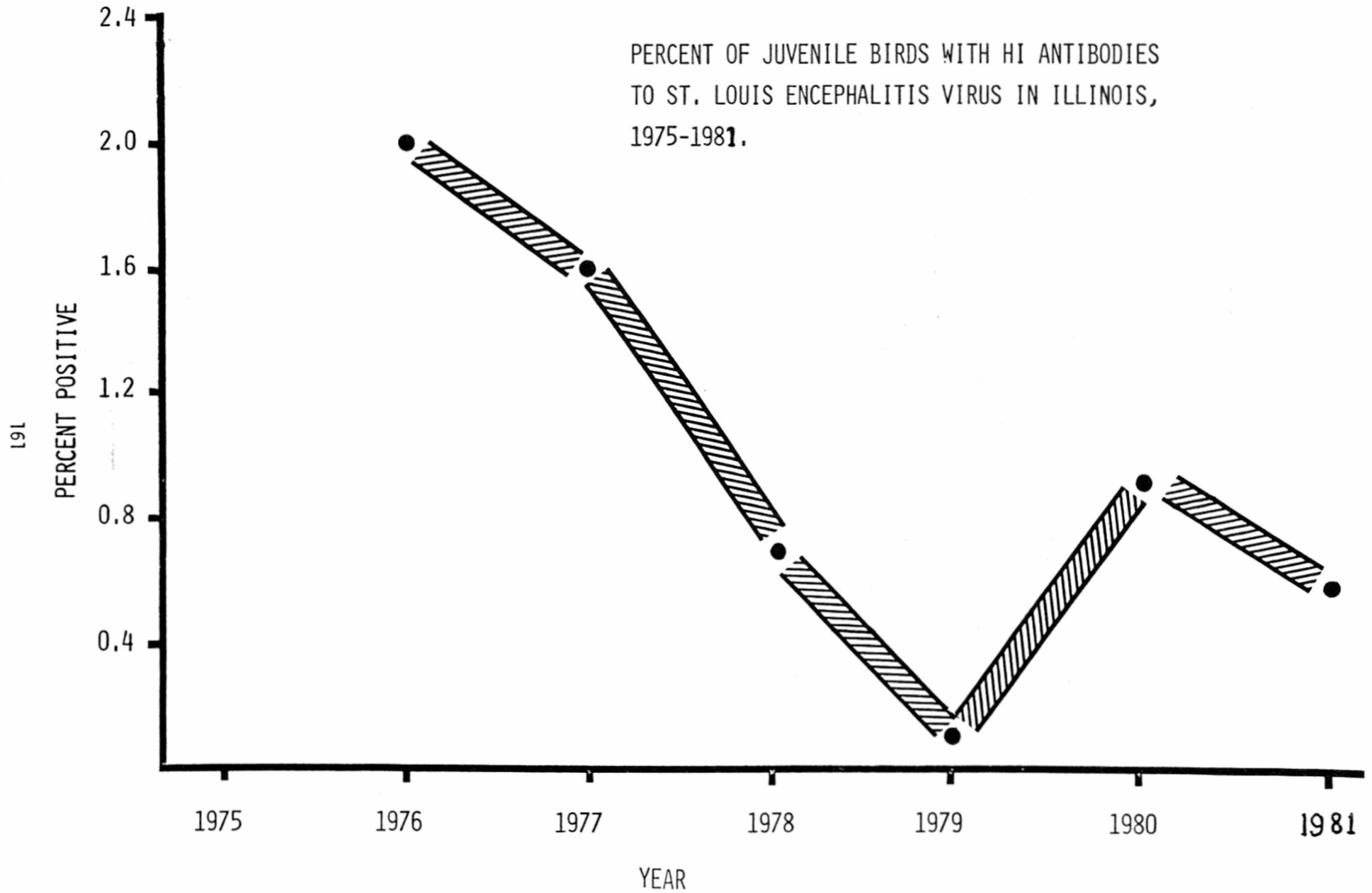
\* \* \* \*

For those that have followed the evolution of our program since 1976, I would advise you of the untimely death of Mr. Harvey L. Pretula. Harvey had an apparent heart attack en route to the laboratory on November 30. As many of you know, he was instrumental in providing the expeditious, high-quality laboratory support that we grew to enjoy and appreciate. His death followed by 2 weeks his receipt of a 25-year service pin from this Department. It also followed by about 1 month presentation of the Difco Award in Los Angeles. This award was for a paper entitled "Laboratory involvement in elucidation of the California encephalitis problem in Illinois" by Gary G. Clark, Harvey L. Pretula, and Hugh-Bert Ehrhard. The paper was selected as the best paper in the Laboratory Section at the 108th annual meeting of the American Public Health Association.

(Gary G. Clark)

Fig. 1.

PERCENT OF JUVENILE BIRDS WITH HI ANTIBODIES  
TO ST. LOUIS ENCEPHALITIS VIRUS IN ILLINOIS,  
1975-1981.



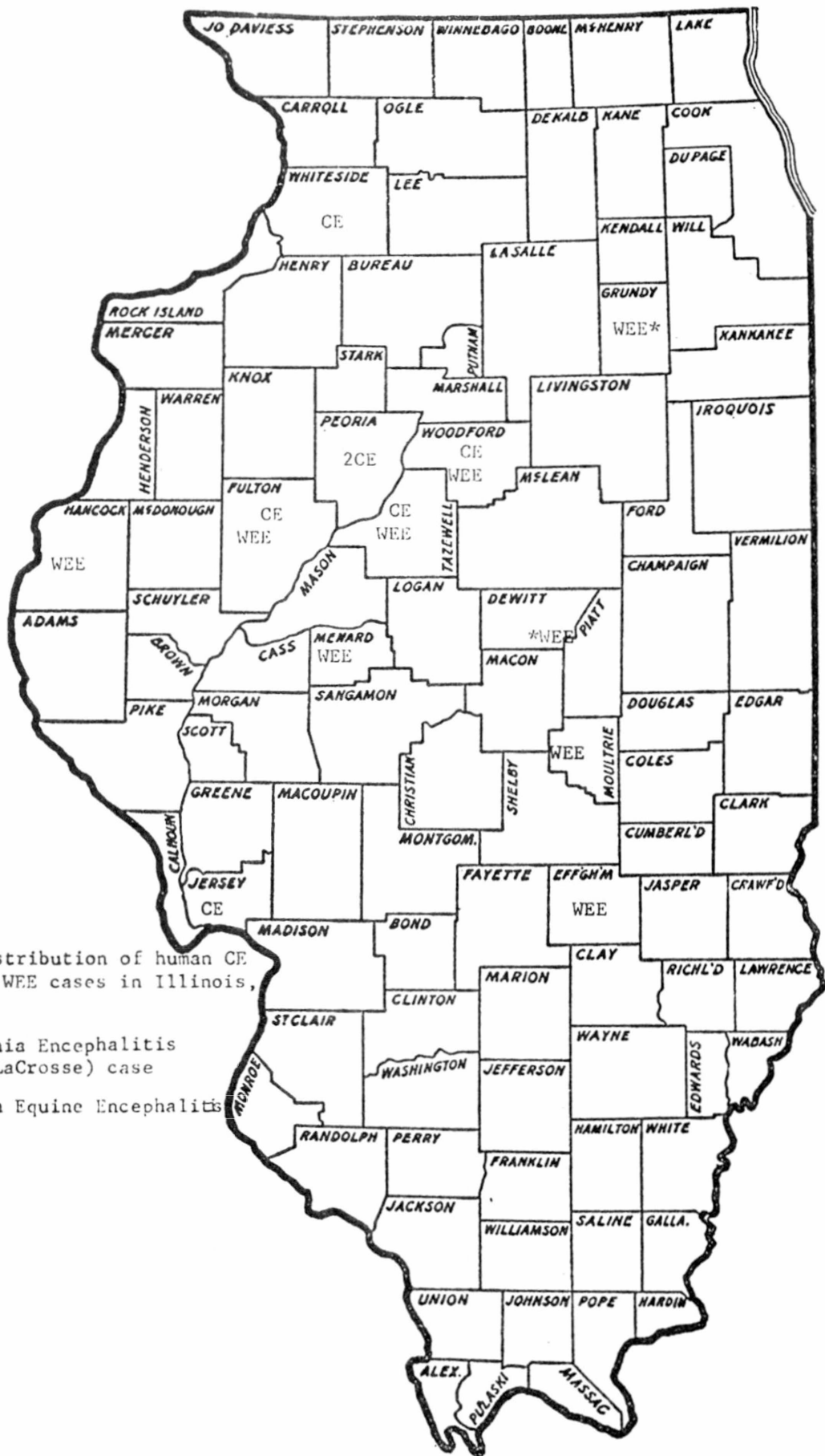


Fig. 2. Distribution of human CE and equine WEE cases in Illinois, 1981.

CE=California Encephalitis (probably LaCrosse) case

WEE=Western Equine Encephalitis case.

\*Fatal.



REPORT FROM THE DEPARTMENT OF VETERINARY SCIENCE  
UNIVERSITY OF WISCONSIN-MADISON

Transovarial transmission of La Crosse (LAC) virus in the mosquito, Aedes triseriatus, is a major means of maintenance in endemic areas. It does not appear to be a completely efficient process, and suggests that it may not be the sole mechanism. The persistence of LAC virus in vertebrate hosts may be another possible mechanism. Transplacental transmission of LAC virus, with the possibility of immunological tolerance and viral persistence, is being explored.

Thirty-three domestic rabbits (Oryctolagus cuniculus) were inoculated intramuscularly and subcutaneously at one of three points in gestation: 10 days, 17 days, or 24 days. The inocula used was  $5.8 \log_{10}$  SMICLD<sub>50</sub> of a low passaged field isolate of LAC virus. Control rabbits were handled as above with media substituted for the virus inocula. At parturition the neonates were bled and body weight, foot length, and skull dimensions (length and width) were measured. Animals born dead or that died after parturition were necropsied and tissues saved for histology and virus isolation.

We could not isolate virus from tissues or blood. Two stillborn neonates had internal hydrocephalus. The brain of one stillborn fetus showed severe dilation of lateral ventricles (1 mm cerebral cortical ribbon remaining) resulting in hydrocephalus (gross examination by Dr. Richard F. Marsh). Histopathologic examination revealed diffuse inflammatory infiltrate in subventricular areas of the lateral ventricle composed principally of small mononuclear cells (microglia).

Data, collected and analyzed, suggest that there is a decrease in litter size (Fig. 1) and in the number of live births per litter (Fig. 2) in litters of females injected with LAC virus early in gestation (10 days). Comparison of standard errors of injected litters to the control litters implies that the difference may be significant. A formal test of significance is being developed. The animals in the affected litters appear to have an increase in skull length (Fig. 3) and width (Fig. 4). Measurements of litters from females infected at 17 and 24 days of gestation do not appear to be different from controls.

Reduced litter size and fewer live births per litter could be the result of reabsorption of the developing fetuses due to a direct or indirect effect of LAC virus. The failure to isolate virus from blood or tissue of neonates does not support transplacental transmission. However, preliminary data on increased skull dimensions and the observations of hydrocephalus suggests that in utero infection may have occurred.

Work is continuing to better document these findings.

Randal J. Schoepp and Thomas M. Yuill

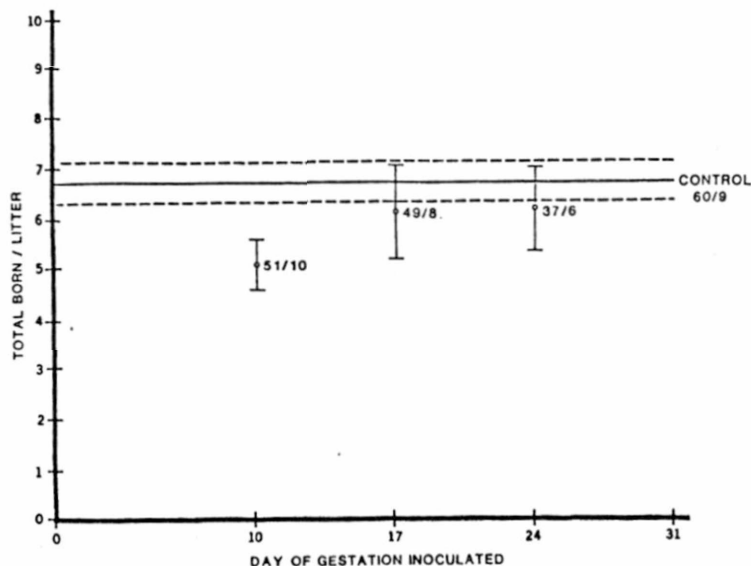


Figure 1. The total number of animals born per litter to female rabbits inoculated with La Crosse virus at 10, 17, and 24 days of gestation.

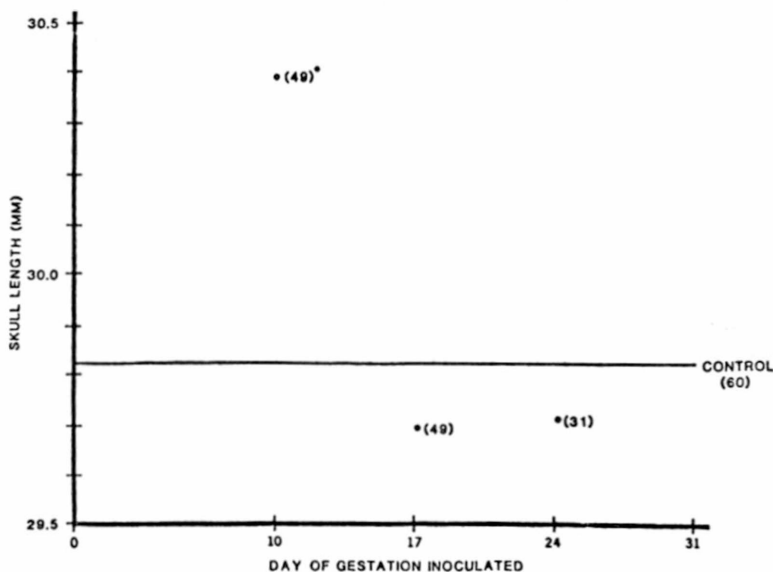


Figure 3. Weighted means of neonatal skull length from litters of female rabbits inoculated with La Crosse virus at 10, 17, and 24 days of gestation.

\*Number of neonatal rabbits included in calculations.

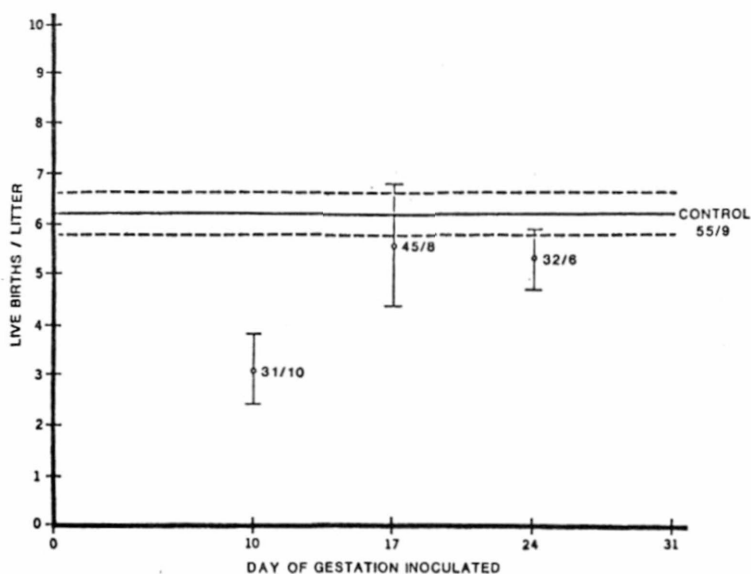


Figure 2. The number of live births per litter of female rabbits inoculated with La Crosse virus at 10, 17, and 24 days of gestation.

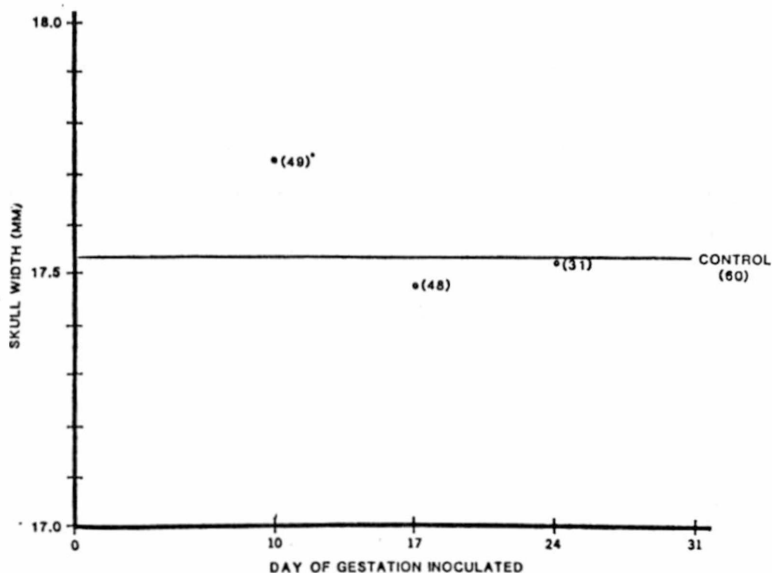


Figure 4. Weighted means of neonatal skull width from litters of female rabbits inoculated with La Crosse virus at 10, 17, and 24 days of gestation.

\*Number of neonatal rabbits included in calculations.

Arbovirus Surveillance from July 1, 1981 to December 31, 1981MOSQUITO ISOLATES

For the period indicated, 542 litters of mice were inoculated for arbovirus isolation. This represents 3673 mosquito pools. Listed below are the isolates:

<u>Locality</u>	<u>Collection Date</u>	<u>Pooled Species</u>	<u>Number of Isolations</u>	<u>Virus</u>
Hill County	6-17-81	A. aegypti	1	Hart Park
		A. epactius		
		C. tarsalis		
		C. quinquefasciatus		
		A. aegypti	1	Hart Park
		A. quadrimaculatus		
		C. salinarius		
		C. (Melanoconion) sp.		
		C. tarsalis		
		C. quinquefasciatus		
		C. quinquefasciatus	1	Hart Park
		C. restuans		
Dallas	6-3-81	C. tarsalis	1	Hart Park
		C. quinquefasciatus		
	7-20-81	C. salinarius	1	Hart Park
		C. quinquefasciatus		
		A. quadrimaculatus		
		C. restuans		
		C. (Melanoconion) sp.		
		A. punctipennis		
		A. aegypti	1	Hart Park
		C. quinquefasciatus		
		A. quadrimaculatus		
		C. (Melanoconion) sp.		
		A. punctipennis		
	7-24-81	C. (Melanoconion) sp.	1	Turlock
		A. quadrimaculatus		
		C. quinquefasciatus		
		A. quadrimaculatus	2	Tensaw California group
		C. (Melanoconion) sp.		
		C. restuans		
		C. quinquefasciatus		

<u>Locality</u>	<u>Collection Date</u>	<u>Pooled Species</u>	<u>Number of Isolations</u>	<u>Virus</u>
	8-24-81	A. punctipennis C. quinquefasciatus C. restuans C. (Melanoconion) sp. C. tarsalis A. quadrimaculatus A. vexans C. salinarius	1	Hart Park
	9-14-81	A. punctipennis C. (Melanoconion) sp. C. restuans C. quinquefasciatus A. aegypti A. zoosophus C. tarsalis	1	WEE
	10-2-81	A. quadrimaculatus A. punctipennis C. restuans C. quinquefasciatus C. territans C. (Melanoconion) sp.	1	Hart Park
Ft. Bend Co.	6-22-81	A. quadrimaculatus A. crucians A. aegypti C. (Melanoconion) sp. C. quinquefasciatus A. quadrimaculatus	1	Hart Park
Tarrant Co.	6-22-81	C. salinarius C. restuans C. quinquefasciatus A. vexans	1	Hart Park
	8-6-81	C. (Melanoconion) sp. C. quinquefasciatus	1	Hart Park
Limestone Co.	7-6-81	A. quadrimaculatus A. aegypti C. (Melanoconion) sp. C. quinquefasciatus A. crucians	1	Tensaw
Galveston	7-23-81	A. quadrimaculatus A. crucians A. aegypti A. taeniorhynchus C. quinquefasciatus A. sollicitans	1	Hart Park

<u>Locality</u>	<u>Collection Date</u>	<u>Pooled Species</u>	<u>Number of Isolations</u>	<u>Virus</u>
Hunt	7-30-81	C. (Melanoconion) sp. A. quadrimaculatus	1	Tensaw
El Paso	7-28-81	C. quinquefasciatus C. tarsalis A. vexans	1	Hart Park
	8-12-81	A. dorsalis A. sollicitans P. columbiae	2	WEE California
Crosby Co.	9-1-81	C. tarsalis C. quinquefasciatus A. vexans P. cyanescens A. punctipennis	1	WEE

#### SEROLOGY

Sera for arbovirus surveillance were submitted from Lubbock, Dallas County, Dallas City and Harlingen. Of 742 specimens tested, the following were positive:

<u>Locality</u>	<u>Collection Date</u>	<u>Species</u>	<u># Positives</u>	<u>Antibodies Detected</u>
Lubbock	8-6-81	Adult Chicken	1	WEE(>1:80)
	8-31-81	Adult Chicken	1	WEE(1:80)
			1	WEE(1:80)
			1	WEE(1:10)
			1	SLE(1:40)
		6 wk. old Chicken	1	WEE(1:20)
	11-3-81	Adult Chicken	5	WEE(>1:80)
			2	WEE(1:40)
			1	WEE(1:20)
			1	SLE(>1:80)
Harlingen	11-4-81	Adult Chicken	1	SLE(1:80)
			1	WEE(>1:80)
			1	SLE(1:320)

#### BIRD BLOOD FOR ISOLATION

Twenty-eight wild bird bloods were submitted from San Antonio. All specimens were found to be negative.

(Charles E. Sweet)

REPORT FROM THE VECTOR-BORNE VIRAL DISEASES DIVISION,  
CENTER FOR INFECTIOUS DISEASES, CENTERS FOR DISEASE CONTROL,  
FORT COLLINS, COLORADO

Studies on the vector relationships of Ross River Virus

The use of Golden Syrian Hamsters (6 to 10 wks. old) as virus donors has been incorporated into a Ross River virus (RRV) transmission model. Following subcutaneous inoculation of approximately  $10^5$  Vero cell PFU per animal, hamsters are viremic on days 1 through 4 postinoculation with peak titers of approximately  $10^7$  Vero cell PFU/ml being reached on day 3. Hamsters offer an advantage over suckling mice whenever it is necessary to feed large numbers of mosquitoes on a single viremic animal.

The results of RRV transmission experiments with mosquito species and strains from Fiji, Samoa, Rarotonga, Tahiti, and Hawaii are summarized in Table 1. The ability of Ae. polynesiensis strains from Rarotonga and Samoa to serve as vectors of RRV confirms earlier experimental work with these strains (Gubler, D.J., 1981, Am. J. Trop. Med. Hyg. 30, p. 1303). The demonstration that Ae. pseudoscutellaris from Fiji and Ae. polynesiensis from Tahiti also can become infected and transmit RRV points up the potential of Scutellaris complex mosquitoes serving as vectors throughout their range. Also, the ability of Ae. aegypti and Ae. albopictus to serve as vectors of RRV indicates a potential for extension of virus activity beyond the boundaries of the Pacific Basin.

(Carl J. Mitchell and Duane J. Gubler)

Table 1. Ross River Virus Infection Rates in Mosquitoes Fed on Viremic Hamsters and Transmission Rates to Suckling Mice

Mosquito Species	Strain	Titer* of Infective Meal	Days Extrinsic Incubation	Infection		Transmission**	
				%	n	%	n
<u>Ae. albopictus</u>	Hawaii	6.0	21	87.2	39	76.0	25
		7.6	21	95.0	40	85.0	20
<u>Ae. aegypti</u>	Fiji	6.0	21	39.6	48	52.9	17
		6.6	21	47.9	48	85.0	20
<u>Ae. pseudoscutellaris</u>	Fiji	7.0	21	98.6	71	58.3	24
<u>Ae. polynesiensis</u>	Fiji	6.8	21	100	18	0	5
	Rarotonga	6.9	17	100	9	75.0	4
	Samoa	6.2	17	100	6	100	4
	Tahiti	5.7	17	93.3	15	40.0	10
		6.6	21	100	8	100	2

\*  $\text{Log}_{10}$  Vero cell PFU/ml

\*\* Transmission rates = number transmissions divided by no. infected mosquitoes refed x 100.



REPORT FROM THE DIVISION OF MEDICAL MICROBIOLOGY, UNIVERSITY OF BRITISH  
COLUMBIA, VANCOUVER, B.C. V6T 1W5., CANADA

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Snowshoe hare (SSH) virus was isolated from 6 of 10,188 unengorged female mosquitoes of 4 species collected at 8 boreal forest locations along highways throughout the Yukon Territory, Canada, between 3 June and 28 July 1981. Mosquitoes were processed in 201 pools. Isolations of SSH virus were obtained from 3 of 7017 Aedes communis including 1:739 on 8 June and 1:174 on 20 July at Marsh Lake (61°N 134°W), plus 1:1973 on 26 June at Dempster Highway Km 222 (66°N 138°W). Isolates were also achieved from 3 of 2088 Aedes nigripes (the first time for this species) including 1:61 at Marsh Lake on 3 June and 2:560 at Dempster Highway Km 222 on 26 June. Virus titers in infected mosquito pools ranged from 2.5 to 3.5 log<sub>10</sub> mouse LD<sub>50</sub> per pool. Cumulative total results for 10 summers 1972-1981 for the Yukon Territory (boreal forest) plus the Mackenzie District of the Northwest Territories (open woodland) revealed 48 SSH isolates and 4 Northway (NOR) isolates from 117,970 mosquitoes of 7 species, all of which yielded a virus isolation during one or more years. The highest infection rates were in A. communis (31:81,044) and Culiseta inornata (8:6407).

(D.M. MCLEAN)

REPORT FROM THE NATIONAL ARBOVIRUS REFERENCE SERVICE,  
DEPARTMENT OF MEDICAL MICROBIOLOGY,  
UNIVERSITY OF TORONTO,  
TORONTO, ONTARIO, CANADA.

Studies on a focus of California Group Virus Activity in Southern Ontario

Studies were undertaken in 1981 at a site in Dunnville, Ontario where strong California group virus activity had been demonstrated in 1979. Sentinel rabbits were placed at four sites within approximately a three-quarter mile range. These sites were selected over varying terrain including two sites in forested areas about 550 yards apart (Sites 1 and 2), one site in scrub vegetation (Site 3) and a fourth site in open lawn (Site 4).

Protocol for the studies was as follows: four rabbits were maintained in a hutch at each site; rabbits were bled weekly and tested for antibodies; mosquitoes were caught weekly at the site of each rabbit hutch by use of CDC light traps; mosquitoes were speciated and stored at -70°C pending virus isolation attempts in suckling mice. In addition, during May, mosquito larvae were collected, reared to adults and screened for possible arboviruses by intracerebral inoculation of suckling mice.

Sentinel rabbits were placed in the field on May 1 and removed on Aug. 31, 1981. Any rabbits showing seroconversions were immediately replaced with new rabbits, so that four arbovirus antibody negative rabbits were continually maintained at each site.

Seroconversions to Snowshoe Hare, SSH, virus antigen were obtained in rabbits at three of the study sites including the two forested areas (Sites 1 and 2) and the area of scrub vegetation (Site 3). No seroconversions were obtained in rabbits maintained in the open lawn area at Site 4.

Table 1 shows the number and dates of rabbit seroconversions that were obtained. For purposes of comparison, the number and dates of rabbit seroconversions obtained in 1979 is also presented. It should be noted that the site of the 1979 sentinel rabbit conversions corresponds exactly to the Site 1 location of our rabbit hutch for the 1981 study.

Neutralization tests were undertaken on sera of all sentinel rabbits that showed California group seroconversions in an attempt to determine the probable infected serotype. Neutralization tests were run against the following serotypes: SSH, LaCrosse, LAC, trivittatus, TVT, and Jamestown Canyon. The results presented in Table 2 show that most rabbits were likely infected with the SSH serotype. However one rabbit, rabbit 3-3, showed specific neutralizing antibodies to TVT virus.

Counterimmunoelectrophoresis was undertaken on the sera of all rabbits that seroconverted. Whereas, specific lines to SSH antigen were obtained in most rabbits, rabbit 3-3 reacted specifically with TVT antigen. Therefore sentinel rabbit serology indicates that two California group viruses were active at our study site.

Six hundred and eighty two Aedes larvae were collected, placed in 16 pools containing identical species and inoculated into suckling mice. No virus isolates were obtained.

Using CDC light traps, 27,632 adult mosquitoes were taken at the four sentinel rabbit sites and placed into 493 pools. Virus isolation attempts are currently underway on the mosquito pools collected. To date, one confirmed California group strain has been isolated. This isolate was obtained from a pool of 100 A. stimulans collected at Site 4 on June 16. Since Site 4 was the only site at which no rabbit seroconversions were detected, this means that California group activity has been demonstrated at all four study sites.

Relevant data obtained from our California group studies in Dunnville can be summarized as follows:

- (1) Recurrent California group virus activity was demonstrated at a site in which extensive activity was demonstrated two years previously. This persistence of a focus of virus activity is similar to that shown for the LAC serotype in the United States;
- (2) Virus activity was shown to extend over a wide geographic range (at least three-quarters of a mile) and over varying terrain including forest, scrub vegetation and open lawn;
- (3) The months of June, July and early August were shown to be the times of greatest virus activity and presumably the times at which humans are at greatest risk to virus exposure.

H. Artsob, L. Spence, C. Th'ng and V. Lampotang, National Arbovirus Reference Service, Toronto in collaboration with G.A. Surgeoner and J. McCreddie, Department of Environmental Biology, University of Guelph and L. Grant, Haldimand-Norfolk Regional Health Unit.

Table 1  
Dunnville Sentinel Rabbit Conversions

Year	Site Number	Number of Conversions	Date of Conversions
1979	1	6	June 30 (2), August 4 (3) August 11
1981	1	3	July 14, July 21 (2)
	2	2	August 4, August 11
	3	2	July 21 (2)
	4	0	-

Table 2  
Sentinel Rabbit Neutralization Serology, 1981

Rabbit Number	Antibody SSH <sup>1</sup>	Titer LAC <sup>1</sup>	To: JC <sup>1</sup>	TVT <sup>1</sup>	Probable Infecting Serotype
1 - 6	320	80	- <sup>2</sup>	-	SSH
1 - 7	160	40	-	-	SSH
1 - 8	≥640	320	-	-	SSH
2 - 2	≥640	40	-	-	SSH
2 - 4	80	80	-	40	SSH or LAC
3 - 3	-	-	-	160	TVT
3 - 4	320	40	-	-	SSH

<sup>1</sup>SSH = Snowshoe Hare Virus  
LAC = LaCrosse Virus  
JC = Jamestown Canyon Virus  
TVT = Trivittatus Virus

<sup>2</sup>-=<1:40